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EPA/NARSTO PM MEASUREMENT RESEARCH

WORKSHOP

"Breakout Group; Health Effects"

July 22, 1998

MR. MAUDERLY: I'm Joe Mauderly. I am supposed to lead this discussion, which in my view is mainly, A. provoking people to discuss and B. keeping you from killing each other. So, those are two sort of, you know, contrary...well, anyway, I don't think we'll have any problem with either. I have a list of what looks like a couple of dozen people that ought to be here and most of them aren't. But we can't wait any longer. So, we'll assume that we have most of the collective wisdom of the group present here in the room. I know many of you, so I know that to be true. I think it would be useful just as a matter of acquaintance to go around the room very quickly and just kind of say who you are and what your expertise is. Because there are some people in the room I don't know and let's accomplish that and then I'll tell you what I think we're supposed to be doing this afternoon.

I'm Joe Mauderly, I'm from the Lovelace Respiratory Research Institute and my background is

toxicology. So, you get kind of a one word statement about your background.

MR. SCHLESINGER: I'm Rick Schlesinger, NYU Medical School, toxicology.

MR. NEAS: Lucas Neas, U.S. EPA, Human Studies Division, epidemiology and biomarkers branch, PM.

MR. WESTERDAHL: Dane Westerdahl, California Air Resources Board. I'm involved in management of our Health Effects Research Program.

MR. JANSEN: I'm John Jansen with the Southern Company. I'm a research scientist there, meteorologist.

MR. MAUDERLY: Meteorologist, great.

MR. HALES: I'm Jake Hales, I'm the Measurement Coordinator for NARSTO. I'm a chemical engineer.

MR. MAUDERLY: Great.

MR. NEWMAN: I'm Lenny Newman. I'm from Burke Haven National Laboratory. I'm not on the list. I'm an Analytical Atmospheric Chemist and non-believer.

MR. MAUDERLY: A non-believer, okay. That's a good one word description. Yes?

MR. TANNER: I'm Roger Tanner. I'm

with TVA and I'm a measurement scientist.

MR. MAUDERLY: Okay. Jane?

MS. KOENIG: I'm Jane Koenig. I'm at the University of Washington and I'm a believer and I study the health effects of air pollution.

MR. CHAMEIDES: I'm Bill Chameides from Georgia Tech. I'm an atmospheric chemist and I'm also crashing your party.

MR. MAUDERLY: That's okay. I'm glad to have everyone. This is going to be the most fun of all the parties.

MR. OLLISON: I'm William Ollison, I'm from EPA, atmospheric scientist and I'm supposed to be here.

MR. CREASON: I'm John Creason and I'm a biostatistician/epidemiologist and I'm the same as Lucas, so I don't have to go through all that stuff.

MR. MAUDERLY: Okay.

MR. DAVIS: Dave Davis, EPA, animal pollutant relation toxicology.

MR. KIANG: I'm C.S. Kiang, Georgia Tech. I'm here to try to find out linkage.

MR. EATON: I'm Cary Eaton from Research Triangle Institute. I'm a chemist, organic analytical and have been mainly interested for years in ambient air measurements, when we're looking at the

FRM particle sampler.

MR. COWLING: Ellis Cowling is my name. I'm at North Carolina State University. I'm a forest biologist and a plant pathologist, so I can think about disease in plants far better than I can think about disease in mice.

MR. MAUDERLY: Plants have health too. Although we usually categorize them differently.

MR. MADDEN: Mike Madden, EPA Human Studies Division, human clinical exposures and in vitro exposures.

MR. MAUDERLY: Okay.

MR. TOLOCKA: Mike Tolocka, U.S. EPA and I'm a postdoc. My background is combustion science.

MR. FRANK: Neil Frank, EPA. Monitoring, you may have seen my name on one or two of the regulations.

MR. FRISCH: Jon Frisch, American Petroleum Institute. I'm an epidemiologist.

MR. MAUDERLY: Okay, great. Let me tell you what I am led to believe and also believe that we're supposed to do this afternoon. Go right through. The fellow right there by the door will take the 50 cents toll.

First of all, I think you've had an opportunity to see the draft written document and it is just that.

It's a starting point. We had a Steering Committee of people that got together and argued about these things for a day or so and developed that draft. There are two purposes, one is a long range meaning of life type purpose, which means we resolve the whole PM health issue, but the more proximal purpose and our job this afternoon, is to see whether or not we need to revise the health part of that document and add to it. That health part had components which were a portrayal of sort of some of the current hypotheses that are out there among the health community regarding important particle characteristics, and I'll come back to that. That's a limited scope. Most of the verbiage was devoted to that, and there was less verbiage devoted to the other two things, and that is, what does the health community have to say about the nature of the measurements that we think must be made, and the citing of those measurements and the frequency of those measurements. So, that's kind of the range of topics that we need to flesh out and those will become kind of the discussion topics. I'll act as provocateur. Rich has agreed to sort of be the recorder, so we can see a product grow on the walls this afternoon. Lucas is going to be the electronic recorder and he'll have a file here at the end of the day that kind of summarizes all this.

Now in order to structure the discussion, and

structure it we must, because we don't have an unlimited amount of time or energy, here are the sort of four questions that I think we can frame and we can just kind of go down through them in turn. Now they are interrelated, but this again we can get off in wandering discussions, but this is the job that we really need to do. One is, there are the 10 hypotheses. Well, is the portrayal of the current health based hypotheses on PM characteristics that might be important, is that reasonable? Not is it all inclusive, of course it's not. Two days later if it were, it would be out of date. But is that a reasonable portrayal of current thinking?

Second, is it possible for us to develop a limited list of measurements; that is, can you develop a list of the four or five or six or eight most important measurements from a health standpoint, or do we say measure everything that is possible and that's as narrow as we can make it. What advice can we give regarding the citing of measurements and what advice can we give regarding the measurement frequency?

Now on the first one, on the health hypothesis, we really need to focus on PM characteristics. This isn't a hypothesis of whether we think it's heart attacks or chronic obstructive lung disease that's killing people, this is a hypothesis about particle characteristics, regardless of the health endpoint, and of course our ideas would be related to

health endpoints and mechanisms, but our purpose today is not to describe or argue about the mechanisms or the health endpoints, as much as what are the range of particle characteristics that we think are important. So, that would be our focus for that one.

The measurements, again, this would be a focus on our ability to prioritize. Is it possible for us to agree that there are some kinds of measurements that absolutely must be done and others that are optional or would be done less frequently. Measurement frequency, here you get into arguments about hourly, daily, weekly. From a health study standpoint, what is required? What can you get from a measurement every six months? Do you get a lot more from a measurement every hour and how does that differ for different questions? Then the seasonal aspect to it. So, these are all questions that get at frequency.

Then finally on measurement location, one topic that we could deal with, for instance, that's very interesting, is should we say there are going to be sites, and they're going to measure everything, and then hopefully we'll link those with health studies and we'll all discover the answer, or should we start with health hypotheses and then say where is the site that could address that hypothesis? I mean those are two different ways of looking at things. Now I'm entering this discussion assuming we have the latitude to think

across this spectrum of issues, but none of them are foregone conclusions. I realize in some cases that might not exactly be the case. Another thing about measurement location, fixed versus mobile capability. If we put a super site in Jane Koenig's backyard, then are we going to learn what we need, or do we really need it on an 18 wheeler and be able to move it around in different places in Washington State, to get the answer? So, these are issues that we can deal with.

Now I won't constrain the discussion to those topics, but we must deal with those topics before the afternoon is over. So, I would propose that we use that as a discussion framework and the four things on the wall, just sort of remind us what this framework is. Is what I have just said reasonable to you? Okay. It's like the preacher that went home. His wife was sick and couldn't go to church that day. So, the preacher went home and his wife said, well, did people like the sermon? He said, well, some said they did, but most didn't say.

So, let's start out with the hypotheses. Somewhere we have slippage in our scope there. I have the, you've all read and probably memorized this report already, I know. But here is just a summary of the 10 kinds of particle characteristics that we discussed in that draft document as current issues or discussion topics that are frequent among the health community.

Now this is a strange list. We have everything from co-pollutants, which isn't really a particle characteristic, to mass, to...I mean that's not a very coherent list. All it was intended to be was to encompass the key issues that health scientists seem to be discussing, trying to study in populations or in the laboratory, and we want to make sure that we're not missing some key issues here to portray. So, let's just talk about that a little bit. Does that list, what does it do for you?

MR. WESTERDAHL: Well, I'll start off on a little editorial to get things started as well. The thing this list does to me is worry me that the chemists in the audience and the chemists in the larger community and modelers, are going to basically take the health issue and turn it into a massive monitoring effort when many of the health community and the epidemiologic community would be happy with a robust measure, time resolved robust measure of particle, number of particle size, sulfate, nitrate and carbon. It becomes a huge shopping list that could easily use up every nickel of money that's available and won't be much left for research.

The other thing that worries me in general about this is we're still generating hypotheses, you might say, in trying to come up with an explanation of hypotheses where the site and its characteristics are being already mentioned today. There aren't any health

studies out here to use as information, but we're going to already decide on what, where the sites should be, what the characteristics of monitoring should be like. So, the two things that worry me is that the monitoring community will use this as a free-for-all to measure everything they can possibly measure, where the health community may not really, if they were asked exactly what they needed, they might not come up with the same list. These are everybody's possible story about how particles may be affecting health.

MR. MAUDERLY: And that's exactly what it's intended to be and that's why we need to get to the next issue. If we're satisfied that this is indeed the list of things people are arguing about, then the next step is to get exactly at that question. What advice do we give the measurement community? Do we tell them they have to cover all these bases or not? I mean, that's an important distinction.

MR. NEWMAN: Isn't part of the problems in this room with this discussion is to try to decide what experiments might be needed to relate some of these characteristics to health effects, as different from just monitoring. In other words, can we go so bold as to say, if there's supposed health effects, that we propose a compendium of experiments to identify the direct health effects of these substances? Is that part of our charter?

MR. MAUDERLY: Not really. It's a very logical and meaningful proposition. I mean we could decide that we're a committee to describe the health studies that need to be done and that would be absolutely interesting, and other groups do that. But that's not really the topic today. The topic today is to focus on, with a health hat on, with those of us that wear that frequently, what is our comment on the measurement issue? It is really not within the scope of time we have or the purpose of the meeting to say, okay, well, now we want to set that aside. What we really want to do is make a list of health studies, but that's my understanding.

MR. NEWMAN: How can you comment on what is the health issue...without knowing what, what to measure, we don't know what the health issues are. We're really riding blind, as you pointed out. Just because we can measure everything and somehow we measure everything and one of those things might be important, none of them might be important. It just might not be an issue.

MR. MAUDERLY: Absolutely. Jane had her hand up here a minute. I'd rather you talked more among yourselves than engage me in an argument. I love to argue and talk about these things, but that's not the purpose today.

MS. KOENIG: We were talking at

lunch about some of the policy stuff, and one sort of solution, right, that you had raised, is to make a lot of these measurements and some of them I guess will be using filters, and archive a lot of things that we need, so we don't use a lot of money doing the analysis. Then later on, as we get to know more about the problem, if we want to go back, say we found that there's an association, epidemiological association between metals in some city, then we can go back to other cities with the archived data and repeat those studies. So that might be a cost-saving way of having it all.

MR. MAUDERLY: William?

MR. WILSON: I think we need to get back to the purpose of this organization, this meeting. The super sites are going to go out and measure all sorts of things for exposure, for source apportionment, model evaluation, and what we need to do is to give them guidance on the four issues you've described and say hey, be sure to measure this along with whatever else you want to measure, here are our priorities of what you ought to measure. If you could measure them here and with this frequency, then we could use them. I think the two types of health studies, Lenny, that the super sites can help are time series epidemiology, where you want frequent measurements, whether it's hourly, daily, or every third day we might discuss, and

cross sectional epidemiology, where you're interested in many more sites, but seasonally or yearly.

SPEAKER: There's also panel studies you could perform in the community. There are four or five kinds of epidemiologic investigations, each of those type of investigations use different kinds of data. So, there's more than just two types.

SPEAKER: I don't understand how you could do an EPI study on things that have spatial variability. The subjects are not in one place.

MR. WESTERDAHL: For example, if you take an old folks home in Baltimore or in Fresno, and you monitor intensely over a three or four week period of time, the heart rate variability and the pulmonary function variability in those subjects, say in the winter and in the summer, they're all in one place, they don't leave, and in fact that kind of study is being done.

SPEAKER: Funny you should mention that.

MR. MAUDERLY: I think you had a point some time ago and you never quite got to it. You've got to be tough in this crowd.

SPEAKER: You don't want to involve chemists who like to measure everything. It seems to me before you can say what you have to measure, we have to understand what the mechanism is of the

particle. Fine particles people tend to think that they came out of a stack or the source was a vapor, in the normal, or it could be just breakdown products, whatever, everything they're composed of may not cause a problem. In other words, a common way to deal with pollutants is to encapsulate it with something like cement. Once they're in there, they don't migrate. You can't suck them out, you could soak it for years, you can't get it out, which kind of says that even though I held this particle and it may contain certain metals, they may not be the component of the particle that actually is causing the problem, and we may need to look at that. Before you can tell for sure about health effects, you need to have some, at least, idea of the mechanism you think is occurring that actually causes the problems. Just because I have this particle sitting here doesn't mean my body's going to absorb the organics. They may be trapped, or it may not be able to get this metal off, unless it's sitting on the surface and just kind of hanging there and then through hypertrophy or whatever forces it goes into the body, or causes, allows something else to go into the body.

MR. MAUDERLY: Well, bioavailability of materials, particles and other media, is a big issue for health studies. I mean your point is very well taken. But let me draw us back to the task at hand, because if we don't march through the task at

hand, which is an imperfect task and again, our task is not to solve the world's questions about the health effects of particles. Our task is to create some verbiage that gives some guidance from a health perspective to a measurement, I don't want to say system, initiative that is going to go in place, as imperfect as it is. So, while it's true that it would be nice if we knew the health mechanisms before we knew what to measure, absolutely, but we don't. In fact, the health scientists are going to say, well, if you tell me more about what the exposure is, I might be able to intuit more about the mechanisms. It's a circular argument. But it will move forward. So, we need to come back, we need to come back to this issue. Yes?

MR. COWLING: My sense is that the bulk of this community sitting here are measurements people and that we do not at this point know what the health community thinks about the prioritization among these. I'm not denouncing your very eloquently stated hypotheses, but it's interesting that the order in which they're on that slide is not the same as the order in which they appear in the booklet.

MR. MAUDERLY: And the order has nothing to do with their priority, as far as I know.

MR. COWLING: I'll bet if we asked each of the health scientists here to express an opinion, a personal opinion, informed by their own

experience, about which do they believe are among the most promising avenues for investigation in the health sciences, then we can get to Lenny's question and design what should be measured. And if there was general agreement that organic compounds appear to be the leading candidate, organic compounds ought to make the list. If mass concentration is not a matter that the health community as a whole thinks is a big deal, or might be a big deal, then mass concentration is further down.

MR. MAUDERLY: Yeah, and that's exactly what our second task is, as I explained it.

MR. COWLING: Okay. Then why is it not useful to begin with the second task before this one?

SPEAKER: Because we're going to add some more things to that.

MR. MAUDERLY: Because my purpose, I recognize not everybody in here is a health wonk, okay? Some of us are and some of us aren't and that's cool. A big love fest here and we'll all learn something. But the fact is, we're marching through a series of steps. The purpose of this is to ask those people who are knowledgeable and have an opinion on the subject, you're all knowledgeable, but you might not have an opinion on this subject, are there hypotheses about particle composition, it's a straightforward

question. Are there hypotheses about particle composition and its health effects that are not encompassed by this laundry list? Either in your mind or you know that someone else is doing work on it. That's a very straightforward question and not all of you will be able to answer that question. I know some of you in the audience can. So, answer me that question. William?

MR. WILSON: On the basis of discussions at the last meeting in Cincinnati, particle surface area.

MR. MAUDERLY: Surface area. Okay.

SPEAKER: That's here.

MR. MAUDERLY: It's also, it gets captured in number and everything else. But the fact is that there are hypotheses that surface is the most proximal parameter to associate with health, within some scopes. That's fair game, surface area.

SPEAKER: We want to be sure we're measuring enough of this to do further tests on it. Are they collecting enough? Is that a concern?

MR. MAUDERLY: That's not an issue right now, how much they're collecting. The issue is what are the health hypotheses about particles.

SPEAKER: Can I help? Maybe I'm out of turn here, but let me do it anyway. We're not

even talking about what to measure. We're just talking about hypotheses. For example, if I look at oxidant injury from an atmospheric chemist point of view, I have no idea what you'd measure, it's a hypothesis for health effects.

MR. MAUDERLY: That's right. Because we know that oxygen radicals can harm cells. So, that's a health hypothesis.

SPEAKER Then we can talk about what are the surrogates that we can measure that might be related to these hypotheses. We haven't even gotten to that point. So, what we're doing, so most of us just need to be quiet and let the health people talk about this.

MR. NEAS: What if I said as a health person, I wanted to know minute to minute the organic compounds in the air?

SPEAKER: That's a secondary,...

SPEAKER: Well, wait a minute, and you should reasonably tell me that this would take the gross national product to measure eight sites, real time analysis of organics.

SPEAKER: But that's not...

SPEAKER: But I think it's important that the monitoring people provide some reality.

MR. MAUDERLY: That's true, but the question in front of us now is should organics be on

the list. Is that of interest to you? Then we'll get to what's real.

SPEAKER: Do we add surface area to this list?

MR. MAUDERLY: The good Dr. Schlesinger has got it on the list. Jane, do you know of people who have what seem like promising hypotheses that aren't encompassed by that? Can you think of some?

SPEAKER: Solubility in water.

MS. KOENIG: Well, no.

SPEAKER: That's a characteristic that fits a number of these things.

SPEAKER: Positive, negative charges.

SPEAKER: Bioavailability.

MR. MAUDERLY: We're not talking about all the particle characteristics of measurement people can think of. This is a list coming from the health community of what they're speculating about, with regard to health mechanisms and they're not speculating about everything that some of you guys know about.

MR. TOLOCKA: Why isn't that a parameter? Why isn't hygro...sorry, I can't pronounce that.

MR. MAUDERLY: We know that

hygroscopicity for instance, when you inhale acid aerosols, it affects aerosol size, it affects deposition site and people are working on that. But people are not, the proximal concern is acid. Hygroscopicity has to do with how strong the acid is and how big the particle is and where it deposits. But the core hypothesis is acid. Does that example make sense to you?

MS. KOENIG: Can I change my answer?

MR. MAUDERLY: Sure.

MS. KOENIG: I think that probably particle size should be on there as a hypothesis. Ultra fines are but particle size itself isn't. And whether something that's hygroscopic leads to particle size and whether that's important. So, maybe particle size-particle size has been the one that we've been testing the most of. But maybe it still is a hypothesis that needs to be tested.

SPEAKER: I would add to that. I think distribution numbers, you know, particle counts are important.

MR. MAUDERLY: In fact in the text that's what's sort of meant by ultra fines, is the size spectrum, but that isn't captured. I understand that completely. We've got particle size and number up there. But let's get, let's make sure we've collected the

health opinion here.

SPEAKER: Just may I share with you our study's perspective. We're the ones involved more in the study of susceptible sub-populations. We sat down and made up a list ourselves without seeing this list and it corresponds and that's encouraging, except we have particle size and I'm sure didn't have oxidant injury. We're doing an endotoxin indoor and outdoor study. We're trying to find out enough information where we maybe can narrow this down a bit. But right now our list matches your list.

MR. MAUDERLY: That's encouraging. Rick, did you get a chance to speak to this? Does this cover you? Rich, does this cover you?

SPEAKER: It covered me before and still does.

MR. MAUDERLY: Still does. Lucas, does this cover you?

MR. NEAS: Yeah, I can't think of anything.

MR. MAUDERLY: Some of the rest of you I don't know. Who's the health person?

SPEAKER: Does organic compounds include everything like pesticides to organic salts and so forth.

MR. MAUDERLY: Yeah, it's organic compounds. Now there are health hypotheses specific

to the allergenicity of organic compounds, the mutagenicity of organic compounds and you can go on down the list. But the reason it's on the list is that there's a cluster of mechanistic hypotheses that all relate to the organic fraction, which we really don't know a great deal about. So, it does cover a lot of things.

MR. NEWMAN: I guess I don't understand why you don't have solubility and insolubility. Solubility, for example, an acid which is soluble or an asbestos particle which is insoluble. Isn't that a characteristic?

MR. MAUDERLY: Absolutely, just like hygroscopicity. If you have metals, just like we assume over here, if you have a particle that has metals and you're worried about the metals, you want to know how they come off. But the hypothesis is metals. The hypothesis is solubility is something on the pathway to dose a cell with metals and it's very important, it's very important. The solubility would be important for a lot of these things.

MR. NEWMAN: The thought there that it's a specific metal that might be doing the harm. But it also could be a specific physical characteristic that could do the harm, like asbestos particles.

SPEAKER: Has to do with the non-mobility of a particle, once it's deposited. The fact that

you have an insoluble particle that therefore is not easily mobilized.

MR. MAUDERLY: The bio-persistence of a particle can work both ways. I mean you have, for instance in the fiber world, those that are more soluble are less toxic, because they don't stick around as fibers. On the other hand, if you're talking about material, an organic mutagen coming off soot, if it stays on the soot and doesn't solubilize and move into cells, then you don't worry about it. So, it cuts both ways.

MR. WESTERDAHL: It all depends on where your concern is. So, if your concern is, are metals in soluble or insoluble form or are organic compounds soluble or insoluble, that's part of what you would do in part of the measurement process.

MR. GARVER: Instead of saying ultra fines or particle size or surface area, can you just say particle characteristics? Because I'm sure the shape or the roughness of the particle comes into play too, so if you said particle characteristics, that would cover everything on the list. It could mean ultra fines could be a characteristic, size could be a characteristic...

MR. MAUDERLY: Well, I don't want to be a wise ass, but we could say particle characteristics and get rid of all that. There are people

who have specific health hypotheses and they're studying these hypotheses that have to do with particles less than 100 nanometers in diameter. Right now they don't know very much about composition, but they know enough to know that there are special concerns for particles that small. That's why it's on the list. Not that those people aren't aware that there's a whole size distribution, but because that's a very specific topic of interest right now among the health community.

MR. GARVER: I meant particle physical characteristics, not just to separate the others out. I mean there's a big difference in whether you get exposed to a volcanic particle that's very jagged and rough edged, not worn, and a worn particle, as far as health effects, at least in the Anchorage area. I realize there aren't too many volcanic eruptions around here.

MR. MAUDERLY: Well, not recently.

SPEAKER: Do we want to put that up as a hypothesis, that the physical characteristics as opposed to the chemical characteristics?

MR. WILSON: No, because then we just have physical characteristics and chemical characteristics, and I don't see the benefit of lumping things together now so we can dislump them later. If you think that the shape and surface characteristics are important, then that should be a health hypothesis, that

is, the physical characteristics of the surface that are important, then you should suggest putting that up.

SPEAKER: That was my original thought, but in listening to what the statement that was made up here, they actually end up being characteristics in some...

MR. WILSON: The reason I put surface area is because Guder Oberdoerffer has the hypothesis that it's the surface area that's important, not some other characteristic.

SPEAKER: These are all based on studies, whether it's epidemiology or toxicology studies that have provided evidence that surface area is in fact a major factor. There are some health scientists that are working on it somewhere.

MR. MAUDERLY: Yeah, there are studies underway for surface area as a variable that's being examined. Again it's what makes the list. This is not a list of all particle characteristics, not even the ones that might prove to be most important. This is a portrayal of what people are working on right now. What the hypotheses are that people are studying in laboratories and epidemiological studies today. That's what it's intended to be.

MR. TOLOCKA: Why is elemental carbon up there? It seems, after reading this it seems like it's just a surrogate for something else. As a

combustion, somebody referred to combustion. I know that you're never going to inhale pure elemental carbon, unless you're grinding pencils all day.

MR. MAUDERLY: Unless you're working in a carbon black factory.

MR. TOLOCKA: But even if you're working in a carbon black factory, don't you have it coated with pH bronchials?

MR. MAUDERLY: But that's a mere detail, it's not relevant to this discussion.

MR. TOLOCKA: I was just thinking about it from an ambient point of view. It seemed that, written in here it seemed like it was more of a surrogate for something for soot.

MR. MAUDERLY: Exactly, and one could put soot there as well. But there are studies where people are trying to associate effects with elemental carbon as the marker. But it is, we're doing that because it's a marker for soot.

MR. TOLOCKA: But not all soot. If soot from sources such as industrial incinerators can be as high as 90 percent organic and if you're looking at that soot, chances are you might not get a, you might not get a good correlation that you're looking for. It's more organic carbon than it is soot.

MR. MAUDERLY: But again there are, I could relate if we took the time, animal studies

that have been looking at carbon compared to soot. That is a soot like a diesel soot where you do have that sort of organics and all kinds of neat things on there versus, you know, the cleanest carbon black you can get. In many biological systems they have exactly the same effect and that's why people have been talking about elemental carbon. Could it be active in some way, and that's why it's on the list. Because it's something that biologists somewhere in laboratories are studying as an issue. That's why it's on the list. In the environment it's principally a surrogate for something because you know, you don't have clean stuff. But you know, you very seldom have a pure metal particle or a pure acid. I mean, those are biological hypotheses.

SPEAKER: Could we put soot, because the studies that we've done in Canada, where we've looked at coefficient of haze and acid aerosols and sulfates and fine and coarse particles, almost inevitably you find COH is a better predictor of hospitalizations for heart attacks or mortality than other particles. So, you know, I always think of COH as a surrogate for elemental carbon. But soot may be as...

MR. MAUDERLY: Well, soot is certainly implicated in a lot of health discussions. It is presumed that that's an active fraction of PM. So, there's no reason not to put soot up there. Let me repeat myself. There are people in laboratories that

are studying the toxicity of elemental carbon particles because they think there might be some answers there. That's why it's on the list, not because it might make sense to you or me, but because that is a current, that is one of the several current hypotheses that people are working on. That's one perspective that it was thought useful to bring forward in this chapter, before we start talking about particle characteristics to measure.

MR. TOLOCKA: But doesn't elemental carbon just become soot?

MR. NEWMAN: Soot is what we have in the atmosphere. We call it elemental carbon, because that's what we, that's how we define what we measure. We define that as elemental... I don't know whether it's elemental, it's really soot that we're measuring, of some sort. We're not measuring elemental carbon per se. I don't know that we as measurers differentiate between the two. You're doing it in a thermal basis. That's the sole basis for the measurement

MR. MAUDERLY: But you're talking from a measurement standpoint. Let me say one more time and then we'll get off of this and get onto the next thing. We're getting tied up in an argument that's not relevant. The relevant argument here is, is this the right list of things biologists are thinking about to study. Whether it makes any sense to an atmospheric

chemist or not. You see, that was the purpose of the list. What are biologists thinking about today? Now it's clear that that doesn't make sense to everybody and that's okay. But that's what it is. So, our purpose is to see, is this still a reasonable list to portray that?

MR. MADDEN: There's some hypotheses related to the charge of the compound affecting its toxicity regardless of what makes up the compound. I don't necessarily agree with them, but I can point to them as a direction that's been proposed.

MR. MAUDERLY: And there are people working on that. Charge as a dose of charge or something.

MR. MADDEN: The charge on the particle.

MR. MAUDERLY: What group is working on that?

SPEAKER: You can talk to Volina Vernathy [phonetic] out in the Park.

SPEAKER: The question being, does that affect where the particles land? That that affects the deposition of the particle?

SPEAKER: That would be one hypothesis, but they're using an in vitro system, so they're saying that regardless of where it lands, it's going to have some effect.

MR. MAUDERLY: So, charge itself is

a toxic, I guess, now an agent of force. That's good. I wasn't aware of that. Put up charge, if people are working on that. I have not heard that spoken of. I've heard it spoken of in terms of the dosimetry.

MR. ZIKA: It seems to me one of those items up there really needs to be subdivided, and that's mainly the metals, because when you say metals that means a variety of things, at least to me. It means, for instance, in brush wear or automobile wear, that sort of thing, you're actually getting particulate metals, metals as the elemental state of metals, which is a very different situation than a metal oxide for instance, which you might get in Minnesota when people get excessive amounts of the red dust in the air. On the other hand, you also have metals that are associated with organic species, such as benza, which are airborne because they're, they're really biological, but they're still metal because they're reactive. But you also have metals that are very different, with respect to studies of metal microorganisms is very different. The same is true for iron, if iron enters as FE2 it is soluble in the lung and if it's FE2 it means that it can initiate cortical benza reactions which are interactions with peroxides. So, you get free radical reactions. So, each of the different species is a very different situation and there's a fair amount noted on the toxicity of these various forms. So, that itself

breaks out a whole series of categories.

MR. MAUDERLY: But is that different from organics? I mean, you can take a piece of soot and you'll have 800, 900 different organics and we've done tox studies on 30, 40 or 50 of them and those are all different categories too.

MR. ZIKA: But the organics as well you have to break them down, those two particular categories. I mean, sulfate and nitrate is sulfate and nitrate. Doesn't have many different forms and that's that. The elemental carbon can be infinite in number. But those two have very...metals and organic compounds have specific categories. There's a lot known about the toxicity and I could give you organic compounds that are going to be extremely toxic and there have been situations where they're shown to be toxic as airborne toxins.

MR. MAUDERLY: We recognize that. The question is, do organics and metals belong on the list, and they do? Not does one word describe all of the mechanisms.

MR. ZIKA: But with respect to the measurements and what you need to know about aerosols, you have to break it out into those categories, because otherwise just saying metals and organics is, it doesn't...

MR. WILSON: But I think that's

something we should do in the second step.

MR. MAUDERLY: Okay. Is there any more comment on this? Yes?

SPEAKER: What about positive indicators of aerosols with specific substances like total mass without crustal material, or conversely, is anyone looking at crustal material by itself as an indicator?

MR. MAUDERLY: Well, I'm trying to figure out how to answer that. I mean yes, there are studies, both laboratory studies and epidemiological studies that are looking at effects of particles that have different composition. In some cases they're primarily crustal and in other cases they're not. People are looking at the differences of those.

SPEAKER: So, in that case should crustal material be up there?

MR. WILSON: Wouldn't this be you're actually talking about various subdivisions of different types of mass? Crustal mass, non-crustal mass, non-volatile mass, volatile, semi-volatile?

SPEAKER: It's, yeah, subdivisions of mass.

MR. WILSON: So I think all of these things are going to be broken down when we get to step two. What we should focus on now is not trying to break them down before we get to step two, but I

guess you're saying should crustal be a separate.

SPEAKER: Well, sulfur gets a subdivision of mass, too.

MR. MAUDERLY: I think we need to move ahead. I think we've got the answer here and the answer is that the health people are saying this covers most things that they can think of. We've got one, apparently there's a group working on charge per se, as it influences toxicity. So, if that's the case, then that's a hypothesis. The other things we're talking about are fine tuning what to measure, and let's get to that, since this is a measurement workshop.

MR. FRISCH: Before you go to that, I'd just like to ask a question about the last category, which is obviously an odd one here. Do you mean just co-pollutants or are there other co-factors that are also in there? It seems we're chasing after the null hypothesis here, obviously. It seems like if you're going to include co-pollutants, aren't people considering other co-factors that go along with PM besides pollutants?

MR. MAUDERLY: Such as?

MR. FRISCH: Meteorological?

MR. MAUDERLY: Yes. Co-pollutants, co-factors, certainly. There are, almost all studies, well, epidemiological studies and there are even some laboratory studies that look at co-factors

and that too becomes a bottomless pit. The reason it's up there is that one thing that the health community is saying repeatedly is that let's not imagine that all of our problems are caused by particles uniquely or by themselves, because we don't know that. And that's why that's up there.

SPEAKER: When you say PM here, that's PM2.5, right? That's what we're focused on here or should we be measuring PM10 as well as 2.5?

MR. MAUDERLY: Yes, I think we are and the health people have repeatedly said that. I mean I don't know any of the health community that's ready to dismiss everything above 2.5.

SPEAKER: So, PM means 2.5 and 10?

MR. MAUDERLY: PM means PM.

SPEAKER: It probably means thoracic.

SPEAKER: Might mean 15.

MR. MAUDERLY: No, not necessarily. Doesn't necessarily mean thoracic PM.

SPEAKER: Isn't the hypothesis PM2.5, isn't that why that's, no? Just asking.

MR. MAUDERLY: Size is a hypothesis.

SPEAKER: No, but in terms of the hypothesis of mass concentration. I mean clearly the

reason the regulation was promulgated, presumably, was because there was a hypothesis that said that health was related to PM2.5 mass, not PM10 mass.

MR. MAUDERLY: No, not true at all. The hypothesis is that PM2.5 encompasses species of materials that we probably ought to consider differently than the larger materials because they might have different effects. They have different composition. They might have different sources. But we still have a PM10 standard and that's still thought to be important.

SPEAKER: In the written document, but not up here, we had peroxides.

MR. MAUDERLY: Well, it's covered under oxidant injury, I guess. The peroxides are a special, there are peroxides associated with particles and that's in the written document. You're not proposing we take that out, are you?

SPEAKER: No, no, no, I just wanted to get it up.

MR. MADDEN: I think that paragraph points to oxidant injury in the last few words. There's probably a better hypothesis, but...

MR. MAUDERLY: Well, it's true, although there are people who would argue that peroxides are a special particle associated species that are important and there are others that say, well, yeah, maybe or maybe not, but it's oxidant injury that

we're really interested in.

SPEAKER: Where's the list.

MR. MAUDERLY: Don't worry about these guys. This is your story. We're asking you what you want. We may decide you're wrong, but we want to ask you what you want.

SPEAKER: When you say... do you mean the volatile organic compounds in the atmosphere?

MS. KOENIG: And the semi volatiles.

SPEAKER: The semi volatiles that come off the particle? There's a difference. Usually when you're getting a....

MS. KOENIG: I want semi volatiles and volatiles.

SPEAKER: And the non volatiles.

MR. MAUDERLY: That's right. We want organics.

SPEAKER: Probably should have pollens in there.

MS. KOENIG: Oh yeah, pollens.

MR. MAUDERLY: You want pollens.

MS. KOENIG: Uh-huh and I probably want...

SPEAKER: You want indotoxins, too?

MS. KOENIG: We aren't looking at indotoxins, no. I don't know. Then all the other

criteria, all the other gases, C0 and 02. Then there's the question of whether we want, yeah, and depending on where you're doing the study you want sulfate and nitrate, too. But we haven't found that we have enough sulfate to make it worthwhile to measure on a daily basis. You'd certainly want to measure it long enough to know whether it's a problem and in some places you definitely want to measure it.

SPEAKER: You'd want to measure acidity, too, I would imagine.

MS. KOENIG: In lots of places.

SPEAKER: Do you want radon, too?

MS. KOENIG: No.

SPEAKER: How about other co-factors?

MS. KOENIG: Well, you have to have the complete meteorology. You want wind speed, wind direction, temperature, humidity, dew point. You have to have all that stuff.

SPEAKER: Liquid water content?

MS. KOENIG: Well, I don't know.

MR. MAUDERLY: See what we're running up against, and this is a real problem with the health community, is that it is absolutely correct that we're sufficiently ignorant about all the things that could be measured and all the ways it could be measured, to formulate our hypothesis. So, the

hypothesis that we have sometimes are very crude. They don't even make sense to you. But those are the thinking tools that we've had to think with.

SPEAKER: Can I ask maybe a rhetorical question? I would think that to correlate, I have to correlate, I should be able to go into the laboratory, since that correlation is derived from such a scatter of information and confounded by so many things that we could attempt to obliterate that correlation, if I get a correlation I should be able to go into the laboratory and select the item that I think that's causing that correlation and the effect, the health effect should hit me in the face. I should see the enormous health effects due to that.

SPEAKER: You would think that.

SPEAKER: It should hit me in the face if there's health effects...

SPEAKER: It did, it just made you unconscious.

MS. KOENIG: You can't expose people. It's very hard to expose anybody, you don't know what it is.

SPEAKER: But this should be easy to do.

SPEAKER: You're going to have her measure the effect on the panel of asthmatics you put in a chamber, how would you help her...

SPEAKER: I assume you've got surrogates for that. You've got dogs or whatever you have.

SPEAKER: Well, even dogs, you're going to expose dogs to a synthetic atmosphere, which components are you going to put in and what are you going to measure in the way of chemistry?

SPEAKER: He's saying these various, you would expose them to these various hypotheses.

SPEAKER: It should hit you, it should be easy to do because the atmosphere has got so many other things.

MR. WILSON: Unfortunately all of the other dumb scientists in the world have been working on this for years and you're just now getting into it. So, we hope in a couple of weeks it will be solved. But let me just mention that when people have looked at the real atmosphere, all be it concentrated, they have produced all sorts of effects in dogs. The other thing that you're missing is that, which has also been shown in animals, is that if you have certain pre-existing health problems, you have much, much more sensitivity to the particles. So, these are two of the reasons why this is not so easy. The first one being that it's hard to expose in a chamber two real atmospheres. The second, it's hard to find sensitive

sub populations.

MR. MAUDERLY: That's the simple answer. Doing the health studies in a laboratory are just as complicated, although it seems like it should be straightforward, as the health scientists imagine that going out and measuring everything should be really simple, but as you've been going on here about it, it's really pretty complicated. There are a lot of complicated things out there.

MS. KOENIG: And I'd also like to point out that when you're doing it in the laboratory you get, you end up being very restricted as to the duration of exposure. The duration of exposure in the laboratory is not going to be very much like the duration of an exposure of a population of the United States.

SPEAKER: I go back to your comment that the health community doesn't understand what can be measured. If you look at this list, just knowing what's been measured in the past...but on this list, for all practical purposes, is all encompassing and as much of a part of the problem as anything to me, having been on both sides of the fence, is a lack of understanding of how these things affect what you want to measure. Are they single effects, or are they interactive effects and the answer is probably both. So, nobody really wants to throw anything out this way. Then we get to the issue of measuring. We can

measure everything on that list. Right now the cost would be extremely enormous.

MR. MAUDERLY: Well, we could measure it but don't know whether it's correct or not.

SPEAKER: They're separate. To me the health community needs to settle on what absolutely has to be measured.

MR. MAUDERLY: Well, but that's the question in front of us. Is that possible? Unfortunately, we don't really have that many health people in the room to answer that question. But the fact is, the health people don't really know. We can't answer that question.

SPEAKER: We can't help what point we are in the health sciences on this issue. We can't help that. We just are there and we have to start where we are. We can't narrow down a list if we don't know.

SPEAKER: Can we make a suggestion then...

MR. MAUDERLY: Let's let this fellow speak.

SPEAKER: If we can't make a list and tell measurement scientists what to do, then I would maintain that the concept of establishing through the supersites what health effects are observed is nonsense. Absolute nonsense. You can go out and get an idea of what the processes are by which they get

delivered to communities for which then health effects are observed. But the concept of using a few selected special sites in order to support health effects research I say is nonsense. Let's go out and develop the techniques that we need to measure all the things to describe the process. Let's let the health effects do as best they can to describe the putative agents and then let's get together 10 years down the road and say hey, are we close, can we measure the right things at the right place. But to go out and set up a few sites and say that we're supporting health effects research, so that we can identify the putative agents of harm is nonsense.

SPEAKER: It occurs we've left out the concept of actually developing protocols to measure in detail things that the health effects community wanted. The majority of the money is focused on health effects. So, why not do both?

MR. MAUDERLY: Let's go to the next topic, which we've been trying to argue our way into now for the last bit of time. For those that came in late, let me just reiterate again. What we're trying to go through is really four steps here. One is to ask the question if our portrayal of the current health hypotheses coming from the health community was inclusive, were we missing anything. The second is, is it possible, again from a health viewpoint, is it possible

to tell the measurement people or the measurement strategists a limited list of measurements to make? Can you pick your top five, or is that impossible. Is it 50 or nothing? To what extent can we formulate advice, as far as the, you know, sort of the minimum number of characteristics that are important from a health standpoint. That begs the question, and the danger is, we'll get into the question then, well, what kind of a site could measure what characteristics. Do we have to measure them at all sites? That's kind of another whole issue and we'll never resolve that. But from a health standpoint and from the discussion we've just had, what are sort of the key measurements. The written document didn't really deal with that. I mean there was a paragraph in there where we talked about, well, you've got to measure a whole bunch of things, to address a whole bunch of hypotheses, but there was no laundry list.

SPEAKER: Can I just ask a question for clarification? This is a limited list of things to measure by the super sites. Is that correct?

MR. MAUDERLY: Yes, that's the discussion.

SPEAKER: Four to seven sites that would be in the United States?

MR. MAUDERLY: Well, we're not presuming how many there's going to be or where

they're going to be. But yes, we're talking about within the realm of possibility of measurements at a site at which intensive measurements are going to be made. Then assuming that there are going to be other sites, which may have progressively more limited measurements to get out here to a compliance monitoring site, might be measuring PM2.5 mass and that's it. In that, the real issue underlying this discussion is, you know, what is sort of the comparison between the number of measurements you make and the health information gains that you make. Are there health information gains to be made, if you measure these four particle characteristics, or do you have to have 50 before we can make any sense of it? That kind of thing, and from a health standpoint is there any way that we can make a short list, or do we just have to say, you guys go measure everything you can and we'll learn something from it. That's the hypothesis on the table. The answer to that is not presumed. What do you think the answer is?

SPEAKER: I believe if you could write down a list of key ones, I don't think you can narrow it down until you get studies that will eliminate some of the characteristics. You just have to be progressive about it, in my personal opinion. That's why we're measuring as many things as we can. If we can come up with four or five that don't seem to have

anything there, then I can come back six months from now and give you a better answer. But right now I don't think anybody knows the characteristics, enough about the physiological effects to give you a list of the key characteristics.

SPEAKER: It might be dangerous to leave one off.

SPEAKER: Can we have the list of 10 back up?

SPEAKER: Prioritizing within those lists.

MR. MAUDERLY: Okay. I don't have a list. Can we make a list? You're talking about the overhead?

SPEAKER: We had a list of PM characteristics. Might that guide our thoughts on...

MR. MAUDERLY: See, I was trying to get this down. You've caused a lot of trouble.

SPEAKER: This is great. Those are hypotheses. Now you're talking about how to measure and what to measure within each one of those.

MR. MAUDERLY: We've just been making an argument that that is an overlapping but different issue.

MR. GARVER: Were you talking long term impacts or short term impacts? How can you monitor for two or three years and know what the long

term impacts are going to be on a population, subpopulation? How does that work? I'm just asking.

MR. MAUDERLY: I'm not sure what your question is. That's my ignorance, not yours.

MR. GARVER: You're talking about taking a list of things that you might monitor for, you might ask us to monitor for, to provide so you can do health research. What I'm asking is, can you rule out any of these without doing long term studies, because you might, let's just say you draw acid, and you say, yeah, I did a year's worth of laundry and you don't see any impacts from acids, but acids happen to take a 10 year impact before they show up in your system. Each person has a different genetic makeup. Some people may not ever trigger it, something may trigger it right away, but it may take 10 years before they trigger. So therefore, can you throw out any of these at all at this point because you don't know. I mean, if you're only looking for short term impacts, you may be able to throw out things after you do a little bit of monitoring. But if you're looking at long term health impacts, you may not be able to throw out any of these for a while. So, I guess you do have to split that. But if I'm doing acute studies, I think in here I can narrow down my list. That doesn't mean long term effects would have the same narrow list.

We're telling people that PM2.5 might take off

six months off their life, if they live to 76. That doesn't sound real acute to me.

MR. MAUDERLY: Well, when you get to be 75 ½ it will be a real concern.

MR. WILSON: There are really two monitoring networks that EPA is developing. One, the so called speciation network that we heard about this morning, will go on indefinitely. That's where we should look for the monitoring for long term effects or for effects of long term exposure. What we should look for in the super sites, which are only going to go on maybe one year at all sites, or maybe several years at a couple of sites is the effects of acute exposure. So, I don't think EPA or the home group has discounted long term, effects of long term exposure or have assumed that if it doesn't show up in time series EPI, we can throw it out in terms of long term effects. There are two networks aimed at these two different types of effects.

MR. GARVER: But the impacts that you may see from these sites in the short term, while you're monitoring, may be a cumulative. People that trigger and that are going to the hospital may have developed their symptoms over a 50 year period, and now they're treating, and it looks acute to you but it's not really acute because we've triggered this problem.

MR. WILSON: Right. We won't see that out of this, we don't expect to. We won't throw

anything out because we don't see it.

MR. MAUDERLY: Is there a presumed life time to this monitoring? The super sites are going to go for five years and disappear?

MR. BACHMANN: Let's say this, that if it's a site that's supporting a health study, a long term health study, for example, as we're integrating this program. Some super sites are going to be like SCAQCS, one hit wonders. They go in for a year or two years, do some episodic measurements and then they're gone. But remember, we're talking about a pretty eclectic mix of things all under one heading. Some of them may be supporting long term health studies before it's all over. If they are, then even if the so called super site funds that the regulatory program happens to be putting in now dries up, it's integrated into the long term research program and gets paid for long term. So, the super sites the first few years are what end up being long term measurement. So, the answer is yes to both. That means you can have some sites that go on a long time and that it's absolutely worth hearing. What would you measuring folks tell people up front, knowing you've got 10 years to go. That would be of interest to know as well.

MR. WESTERDAHL: I think to follow what John had to say, maybe the way to make some progress here is to have some of the health

investigators say what they'd like to know if they were doing a panel study on cardiac patients or asthmatics, versus what someone in the Academy might want to know about development of some sort of development of the disease process because they were different. In one case you're looking for acute responses and the other you may take years to accumulate a response. So, that might be a way to make a little progress. Jane, if you wanted to do an acute, an asthma panel study over a couple of seasons, what would you want to have measured?

MS. KOENIG: I'd want to have PM10, PM2.5, PM1, ultra fines. Actually coenzymes, I'd like to have another enzyme. I'd like to have XRF, a measurement of soluble metals, ability to measure organics, volatile organics, probably a Puff sampler, something like that. I'd want to be able to differentiate between organic and elemental. I'd want to measure pollens and all the other criteria pollutants, at a couple co-located sites.

MR. WESTERDAHL: But you don't want sulfate and nitrate?

MS. KOENIG: Well,...

MR. WESTERDAHL: I think you missed one.

MS. KOENIG: I want them, but...

MR. MAUDERLY: Now you're

prompting.

SPEAKER: Can I ask you a question about the couple of co-located sites? Do you really think you can do that in two sites? It's one of the things that I'm always concerned about when we talked about criteria pollutants is spatial variability of criteria pollutants in an urban area can be very different from one pollutant to another. For example, sulfur compounds or carbon monoxide, I don't think you can tease out that relationship. So, how do you do co-pollutant interactions?

MS. KOENIG: Well, you'd want to do some mobile monitoring.

MR. WESTERDAHL: Well, that's the next question, is location. So, maybe work on that one next.

MS. KOENIG: I would like other suggestions.

SPEAKER: When you say PM10, PM2.5, PM1, it's almost, it really sounds like....

SPEAKER: That's what you guys call it. Do you want size distribution, do you want mass?

SPEAKER: I think number's more important. You can get number much easier than mass.

MS. KOENIG: Right, you have to make the mass measurements in order to do the daily, you have to have the daily mass measurements in order

to get a time series XRF.

SPEAKER: It's a separate issue.

MS. KOENIG: Well, there's no point taking donor samples daily without knowing what the mass is.

MR. NEAS: Well, the assumption here is that it's going to be done by Pfister. You can do particle size distribution counts that don't necessarily relate to mass on line real time all day long.

SPEAKER: For good or ill...

MS. KOENIG: Lucas, I think that for epidemiological history we need to continue making the mass measurements.

MR. MADDEN: If you can't reproduce what's been reported in the epidemiology journal reports that are driving this issue, then we're in big trouble. I think everybody probably in this room would probably agree on that.

SPEAKER: Well, there are no experts on how to measure things in new ways.

SPEAKER: What we're talking about here is what you can measure. Now granted it doesn't mean that that data can't be correlated back to mass measurement, so that you can develop a correlation between what you've had and new information. You can't avoid new information just because it doesn't

easily correlate with your own data. You may have learned something from having a complete distribution as well as a mass measurement versus, and you can actually, there are people working on technology to take that same particle and give you an elemental analysis as it passes through a beam, so now you know the metal concentration based on size distribution.

MR. MAUDERLY: But now we're arguing with a health scientist on the basis of what we can measure and what our key questions are. The question for the health scientist was, do you want mass and the answer is, you want size distribution but yes, you also want to know what portion of mass is in each of those size ranges. The answer is yes.

SPEAKER: Why? I want to know why.

MR. MAUDERLY: Because that's dose. Mass is one measure of dose.

SPEAKER: It could be really complicated. It could be really simple and it's just total mass burden. It could be.

MR. MADDEN: I want mass to see what the concentration is outside. That's what's been reported, increases in concentrations, increased morbidity and mortality.

MR. MAUDERLY: That may not be the answer, but the answer is health scientists want to

know how much mass is delivered to your trachea, to your alveolus. They're interested in that.

SPEAKER: Enabar and anabar.

MR. MAUDERLY: We don't know what that means, but what we want to know is...

SPEAKER: Mass is a function of size and you want the numbers.

MR. MAUDERLY: Yes.

SPEAKER: Yes.

MR. MAUDERLY: Now what else?

SPEAKER: Surface area.

MS. KOENIG: XRM.

SPEAKER: If you know anabar, you've got surface area.

SPEAKER: You can get surface area.

MS. KOENIG: Soluble components, sodium and potassium, several things like that.

SPEAKER: You want to say elemental concentrations, not external. Talking about the method of measurement there.

MS. KOENIG: Organic, carbon, elemental carbon.

MR. MAUDERLY: Now wait a minute. You said soluble metals and, but you weren't interested just in metals, you were interested in soluble...

MS. KOENIG: Potassium, things that

can be...

MR. MAUDERLY: Next.

MS. KOENIG: Organic carbons.

MR. WILSON: I think maybe it's useful to recall the history of why we're here and that's because measurements, very, very crude measurements made to determine if cities were in compliance with TSP and PM10 standards, provided the epidemiological data which says there's a correlation between particle mass, a variety of pulmonary illnesses, and that has driven the standard and a lot of other things. We have the opportunity now to guide the monitoring people to give us something that might be more useful to the health people than TSP and PM10. Now we can say, well, forget about that. You guys go measure what you want to. We're going to do something for 10 years, maybe we'll do studies in the laboratory on individual chemicals and we'll come back and in 10 years maybe we'll be able to tell you what to measure. I think that's nonsense.

MR. NEWMAN: William, you know very well that the measurement of the particle mass might be a surrogate for something else and that just saying it correlates is not cause. It's the cause....

MR. WILSON: Who suggested it was?

MR. NEWMAN: You're suggesting

right now wanting to measure every possible component of the particle and it might not have anything to do with particle mass per se. All these are going to be measured and that's why I say it should hit you in the face. If it was due to particle mass, you should be able to even expose animals to particle mass and see this thing killing them right and left and it doesn't seem to do that.

SPEAKER: You can do a 250 microgram per cubic meter and you can kill an animal in concentrated outdoor air, but so what?

SPEAKER: But we're not able to experimentally produce the right particle.

SPEAKER: That's right, that's right.

SPEAKER: That's been enormously difficult. The toxicological experiments that demonstrated mortality in animals used concentrated ambient particles. It is, people have spent their careers, Mary Ander spent her career trying to develop the right particle. It is not easy. Oxidative potential, if I could get that on this list. It's been floated by some. I think it would break the budget.

MR. MAUDERLY: Well, the way we started on this was to ask Jane if she were doing a certain kind of study what would she want.

MS. KOENIG: Well, you asked...

MR. MAUDERLY: If we started with a list. And I think it's appropriate to ask, from an epidemiology standpoint, you or Rick, what do you want. What would you add to that? Let's go ahead and flesh this out. Remember, the question on the table is: can the health community give advice that in some way narrows the scope of measurements to those that are thought to be most important? Now the answer to that may be a simple one liner...no. Okay. But that's the question. That's what we're here asking. Can the health community do that? Can we even narrow it down to 10 things, 10 parameters?

SPEAKER: Sounds like we're broadening it.

MR. WESTERDAHL: Let me go back to Jane again, since I asked the question about it. What would you be satisfied with doing as a panel study, as opposed to what would you like? What is it that you think...what do you really have to have? What can't you get by without?

MS. KOENIG: I don't think I know the answer to that, because we have shown in Seattle that asthma is associated with PM and carbon monoxide. Both in terms of hospital admissions and emergency room visits. So, now the question is, what is really, what is really aggravating asthma. So, we don't have an answer.

MR. WESTERDAHL: Would you be, for example, would you be satisfied if you had a robust time resolved database on mass concentrations at 10, 2.5 and 1, sulfate, nitrate and carbon? Do you feel you could do a study with that that would be useful?

MS. KOENIG: Well, the carbon would be useful. We don't have sulfate and nitrate that much. So, either we decide that the PM2.5 mass, I don't think we're going to decide that it's carbon monoxide. So, somehow or other we have to chip away at PM2.5 mass or actually it's fine PM1, even though the methyl, the meth, light scattering is just as good of a predictor of the asthma ER visits as PM2.5. So, it's probably finer. But I think that ultimately we'd like to know what component of that finer stuff would mechanistically aggravate asthma.

MR. MAUDERLY: In fact if you had that list of measurements, that I think you quoted, you had a small number of measurements, Jane would do a study. She'd write a grant and try to do a study with the information she had. Now the flip side of that is, what would you like to have. Well, that is only limited by your imagination, because she doesn't know what the answer is. The health people can't tell you just what they'd like to have. Rick, let's get some perspectives from other kinds.

SPEAKER: Talking about the, this is

a list of characteristics?

MR. MAUDERLY: Yes.

SPEAKER: Because some of it overlaps the first. What would you measure? You're not confining this question to PM characteristics are you, Joe, or are you?

MR. MAUDERLY: We're talking about particulate matter characteristics, and the question on the table is: is it possible, from a health perspective, not from a measurement perspective or some other perspective, is it possible from a health perspective to cone in on a limited number of measurements that we're confident are most important? Is the answer to that anything other than no? Okay?

MR. FRISCH: Is the question you're really asking, can the health people prioritize which hypotheses are the most likely to produce...

MR. MAUDERLY: Well, yeah. Your perspective would be based on your hypotheses and that's what Jane is sitting there trying to think through. You're asking measurements, well, what's my hypothesis about whether this could do it or that could do it. But the question we're asking is, do the health people know enough to be able to give you a prioritized list of measurements?

MR. FRISCH: To me what you're asking is, is there consensus of the health community

on which of these things are the most likely to be causes...

MR. MAUDERLY: Indirectly that's absolutely right.

MR. FRISCH: And I don't think there is that consensus.

MR. MAUDERLY: And I agree with you. But that's a question we're supposed to be asking.

MS. KOENIG: But as a member of the health community, we are not expecting, I don't think, the same hypothesis to be associated with mortality as associated with asthma.

MR. WESTERDAHL: But, for example, there's no good reason to believe that changes in heart function should be caused by the same things that might cause bronchitic problems or cause asthmatic problems.

MS. KOENIG: Oh, it's not a simple hypothesis, one mechanism.

MR. MAUDERLY: We're not even confident that we know what all people are getting sick from, what the processes are or how they're dying. I mean we don't know that. If we did, if we knew for instance that it was lung cancer that was causing everything we see in particles, then we'd go study lung cancer hypotheses. But we only have a rough idea of even what the spectrum of conditions are, acute and

chronic.

MR. GARVER: A lot of times you're making your assumptions on those conditions, based on somebody's diagnosis that may or may not be the right diagnosis.

MR. MAUDERLY: Well, there's that possibility too. Let me get to Rick. He's been waving his hand at me and he's been nice enough not to jump up and throw something for a long time.

SPEAKER: One of the things, we also find a very strong CO effect on asthma hospitalizations all over Canada and we're going to have another big study in Toronto shortly. I was at a meeting two weeks ago where Frank Speizer went nuclear on me and said that can't be true, that can't be true. He's a statistician. Anyway...as a statistician though, one of the things that is really important in the analysis is to get more orthogonal predictive. When you get variables that are all correlated, then you're teasing it out and you change the stations. You have one variable is just a little stronger and it wipes out the other one. What I'd like to see in a hypothesis is things that are really independent in space and time. But even if you could do that, like sulfates and elemental carbon, you know, are not as correlated or whatever, if you could even get sort of on an axis of study, but when you're measuring basically 50

measurements for the same combustion source or something, then it's really just luck that one study finds CO is better than N02 or particles are better than...

MR. MAUDERLY: It may be a measurement error and you should leave it out.

MR. GARVER: It could be a measurement error. So, if you could find things that actually had sort of an orthogonal predictive power, possibly different biological hypothesis, even if you could separate things so crudely like that, that would be a huge step.

MR. WILSON: I think it's important to remember that that's one of the goals of this list portion, and the way you get back to analysis is to determine which components are orthogonal and so you can associate them with different sources. So, one of the big studies that's going to be going on, is to find out what components or sets of components go together and are orthogonal and they're interested in associating them with sources. The health people might be interested in saying well, are any of these more or less correlated with health effects than something else. If we find something that is, then we know where to pursue, we've got a clue that's useful.

MR. TANNER: Multiple species are found on the same particles, even if they're orthogonal. That's the problem with using factor analysis. Factors

you get out may relate to sources, but they may not relate to effects at all.

MR. WILSON: One of our people just said it would be nice to know what's orthogonal. I'm just saying that we're going to be getting that information and if we think, the health people think that would be useful to know, it would be nice to say so, and to provide that information. Hey, we'd like to see what's going on.

MR. WESTERDAHL: Warning people that multiple measurements aren't always the best, aren't necessarily going to give you the answer because they're highly related measures. They're not...statistically you can't take them apart.

MR. BURNETT: Well, you can't take them apart and what happens is, they do one study and you find one measurement is a stronger predictor than the rest and you put them together and it wipes out everything. So, you get this thing and then another person does a study somewhere else and it happens to be that that other co-pollutant is a little bit stronger so it dominates and you think it's that thing. You're all measuring the same thing. They're all surrogates for something else and you're just pretending that you understand something about it. You need really, it would be really nice to have these kinds of really differential effects or at least differential temporal or

spatial patterns and you really, to tease those out, you're actually, what you're measuring is actually the causative factor. If we measure too much stuff in here, you could just be repeating, put a lot of money in just measuring a source and maybe not getting really into the problem.

MR. MAUDERLY: You had a question a moment ago.

MR. KIANG: I'm worried about one thing, from the health point of view, that you maybe find out there's some kind of thing about asthma or heart or cancer or anything that's something that even we don't measure, even we don't know. Is that possible? There is something over here because we never measure it, so you never know that's the one. Because I remember 20 years ago when I come to Atlanta and I say hey, you have ozone problems, they say we don't have it. It's very simple, they never measured it. What I'm trying to say is this, if you really want to see that kind of a possibility, you almost can write down a wish list of everything you want, because that may be something you can exclude it, because you never find it before. So, I'm thinking about, it's very dangerous about this, you know, looking for some possibility and without any hypothesis. So, I think the point I would like to say is just, we should make some of the hypotheses, also maybe in a different location, different region. They

maybe have a different hypothesis. Not just like one regulation for everybody. 50 sites, you're measuring exactly the same thing. So that's usually the policy at some of the departments. There you find something in that location which is very different from the other. So, I think about the regional characteristics you must be aware and quantify and define and then see the statistic about what the health problem. Then maybe we can have some better hypothesis. You can get worldwide expert, everybody come from different. You know, like Jacque Solina, from Europe, he will see everything different, because they have ammonia everywhere. You know, situation in the United States may not be the same and then you have the scientists and the health people get together and you find it entirely different. They can argue four days, or four years and don't get any answer.

MR. MAUDERLY: Well, you make two points that are really well taken, that I doubt there will be much disagreement with. First of all, from a health standpoint we hesitate to tell you not to measure anything. Because we don't know what might be there. The second thing, it is very unlikely to be the same everywhere. But I think you've got to go back to what William said and that's a good point. Why are we even having this discussion? Well, we're having this discussion because lo and behold, over a period of

years, it became evident that there were associations between mass and health and that surprised a lot of people. From a toxicology standpoint, we really didn't have the sense that those low mass concentrations should be doing these things. Well, now we think we understand a little bit about how they might be doing those things and they probably do in some cases. Then the health scientists quickly got very clever and said whoa, not all particles are alike. Well, that was a revelation. We have a background in toxicology and health studies that gave us reason to believe that different particle characteristics could have different effects. We thought ourselves clever. But now we need to go out and measure different particle characteristics because we believe that we might be able to discover which are the most important to control. But we don't know which are most important to control. So, the question on the table is, is there any way that we can give advice that would limit the number of measurements. So far the answer to that question has been no, we can't give you any advice that would limit the measurements. Does anybody argue with that premise?

MR. WESTERDAHL: Certainly not from a one shot sampling health study. I mean that's part of the thing that hasn't been mentioned. And let me build just a bit on what he said. If you were trying to

say if you have one opportunity to measure the heck out of everything and to do a health study, what would you have measured and the answer is everything.

SPEAKER: I don't believe I've mentioned mixing ratios, that were mentioned in the plenary session this morning. I don't know whether that would ever be useful.

MR. MAUDERLY: The health scientists aren't driving that argument. That's the atmospheric modelers. You wouldn't demand...

SPEAKER: There are stuff that have been floated to measure at the super sites, but that as a health effects person, there's no health effects argument to be made for these. So, do you want us to limit it?

SPEAKER: Is that what you mean by mixing ratio, vertical variability?

SPEAKER: Yeah.

SPEAKER: I can tell you a reason for doing it, from a health point of view, if you want.

SPEAKER: Okay.

SPEAKER: That is when you make a measurement right at the surface, the representativeness of that measurement spatially is extremely limited. As you get a little bit higher up in the atmosphere, you begin to actually sample air that is representative of a much larger area. But that air is

mixing with the surface air. It's just more...but if you measure at the surface you're measuring air that's representative of the five foot square area. It's only representative of the people that actually walk right by your monitor. I'm not saying it's the answer, but from an epidemiological point of view, an exposure point of view, it could turn out that by measuring at a certain height, not necessarily 200 meters, but at some height, you're actually measuring air that is more representative of the dose exposure of people outdoors than measuring by the surface.

MR. CREASON: In Baltimore, I measured two sites, 10 miles apart, one indoor and one outdoor and I got almost exact overlay. In Baltimore over four weeks.

SPEAKER: That might turn out to be true, but we don't know that. And certainly for other pollutants we know that that's not true.

SPEAKER: I'm not saying that you shouldn't measure it, I'm just saying that no health scientist is going to run in and demand mixing ratios.

MR. MAUDERLY: But what a health scientists wants to know is all I care about is what people breathe. A health scientist wants to know that. If your vertical mixing ratio will help you predict what somebody is breathing, then we'll agree it's important. But nobody is going to, you know, the health scientist

isn't going to demand that, you've got to tell him it's important.

MR. KIANG: The health scientist is thinking about everybody that breathes has the same air.

MR. MAUDERLY: No, we're a little more clever than that. Let's go back here.

MR. GARVER: Let me put that question in a little better perspective. Everybody is concerned about PM2.5. 2.5 is consider homogenous long range transport, regional haze, all kinds of the same thing. People climb up and down mountains, so we're not just looking at the surface and where we normally usually look at the surface. So, you can sample, you don't have to go up the top of the mountain to get to ambient conditions at 1,000 feet. So, if you do look at this it gives you maybe a bigger picture of the overall, if you want to call it background concentration, as opposed to the micro scale that we may see. We were talking about monitoring at two different sites. In Baltimore, I mean, that's representative of those two sites. Those may be representative of the entire area, they could be hot spots, they could be anything. So, just because 10 miles away the two sites have the same concentration doesn't tell you anything. In the past we've tried to say 10 miles apart, both same concentration, it's all homogenous, and that's not true.

You're right, that's spatial variation. So, I think that there is some good justification for looking at altitude.

MR. MAUDERLY: The point needs to be made, 2,000 feet over Los Angeles is not the same as 2,000 feet up Sandy Hill Mountain in Albuquerque.

SPEAKER: No one is saying 2,000 feet.

MR. MAUDERLY: There were a couple of hands over here and we've got two issues to deal with. One we've tinkered a little bit with our list of hypotheses. Two, I think we've said that no, that health scientists can't limit your measurements. We can't do that, so don't look to us to prioritize them. There are two other questions, and I'm presuming that somebody might want a biological break for 10 minutes before we tackle them.

MR. NEWMAN: Joe, I don't want you to dismiss the priority. I think it would be useful to put them into two categories, mandatory and desirable. Because if you have them all there, you might get nothing of if you get something, it might not be a considered set of measurements. I think it's better this community should give some sense of priority to what they want measured. Maybe limiting it to two categories is maybe as far as you want to go, but I would think it would be useful.

MR. MAUDERLY: Do you want to

suggest a process for doing that?

MR. NEWMAN: It's up to you people to tell us. Jane gave us a list that's impossible to meet.

MS. KOENIG: No, no, that's not true.

MR. MAUDERLY: That's not a very long list.

MS. KOENIG: No, it's not. I'd like to know who would suggest a super site that didn't measure these things.

MR. MAUDERLY: That's right. I mean you don't need the health people to tell you to measure mass and size distribution. I mean, you're not going to tell me you're going to set up a super site that doesn't do that. So, you're asking us to stretch our imagination about the lunatic fringe of measurements that we're only learning about from you guys.

SPEAKER: Can I ask a question about the lunatic fringe? Two of the hypotheses, and I don't mean to characterize them as lunatic fringe, biologicals and had to do with toxins. I don't see any reflection of that in those lists.

MR. MAUDERLY: Remember, we were asking Jane for particular studies.

SPEAKER: What I'd like to know is to address those two issues, what would you measure, just as an education? What would you measure in

particles to address the issue of toxins? Would you just measure peroxides?

SPEAKER: Probably measure the valence state of the metals.

SPEAKER: Maybe what Lucas suggested, oxidant potential, oxidizing potential. I think that ought to be on the list.

MR. MADDEN: Metals would be one thing for getting periodical reactions and quote, unquote, biologicals, which would be some sort of a measure of the LPS endotoxin fragment.

MS. KOENIG: We've got soluble metals up there.

MR. MADDEN: LPS, lipopolysaccharide. Hey, I don't know what XRM is, so.

MR. MAUDERLY: Yes, go ahead.

SPEAKER: Looking forward to it?

MR. MAUDERLY: No.

SPEAKER: I agree with this gentleman. I think we're grossly remiss not to try and cone down. Lest we create the impression for some reason that we're here to sort of guide and interact with other folks and come out with egg on our face, we can't do it. I think we should make every effort not to sort of be that way. I also submit that if in the next decade we can make substantial headway on relatively basic questions, we will have done a damn good job

epidemiologically. For example, if we could get a more holistic and more competent sense as to the relative, shall I say short and long term health effects of particulate and gaseous exposure, we will have made a very important contribution. I submit that if we think to some extent along these lines, we may be able to cone down. I don't think it's a matter of we've got to have everything to make a nice contribution at all.

MR. WESTERDAHL: I agree on the super site issue especially.

SPEAKER: I actually think the super sites have the least likelihood of advancing understanding of ambient air pollution health effects. I think they may prove to be interesting tools for a tox's generation. But in terms of really effectively, confidently addressing the questions that now confront us in epidemiology, I think the action really lies in some upgrading of the monitoring repertoire, the repertoire of pollutants measured at the lower level sites and substantial upgrading of the frequency and overall time period that they do the measuring. I think super sites from the health point of view are largely a written area.

MR. MAUDERLY: Well, let's come back though to the issue at hand and that is whether or not we can give any advice in terms of limiting measurements? Do you want to suggest a process for

wresting that advice from this group?

SPEAKER: I'll take a risk, I'll suggest seven or eight things and you can shoot me down.

MR. MAUDERLY: Okay. Do you want to take a break before we do this, or are you good until 5:00 o'clock or 6:00 or 7:00? Okay, 10 minutes. You can find a potty in 10 minutes.

(**WHEREUPON**, a brief break was taken.)

MR. MAUDERLY: Let's get back to order and try to pick up where we left off. I remind you that we had four issues we were going to cover. We've just kind of gotten into the second one. We're doing a lot of stumbling around, but this is very healthy stumbling, I guess. You know the proposition that I put on the table was, well, look, it sounds to me like the way folks are floundering around, we can't give any advice from the health side, as to how to limit the number of measurements or prioritize them and that provoked an alternate response of, well, yes, we could. So, now we'll try that. But we actually can't spend a great deal of time on it. We've got to touch on these last two issues as well. I'm presuming that people don't want to stay here until 7:00 or 8:00 o'clock this evening doing this.

Key PM characteristics. Now the proposition over here was, well, yeah, I could take a cut at listing

some and so the process we'll do is to let you take a cut. We'll all shoot at it and see if it makes any sense to us. If it does, well, we might use that and if not then it will prove my hypothesis that we can't do this. So, prove me wrong.

SPEAKER: Well, I like your logic, I like the way of setting it up. We'll shoot first and then assess the logic later.

MR. MAUDERLY: You give us something to shoot at and you can do it up here, or Rich can write down what you say.

SPEAKER: Actually let me start with item four on your list. I was going to start off by saying the things that I'm going to sort of name are straw man, shoot out things, I would propose to measure wherever they get measured. Every day for at least 10 years. The PM characteristics that I'd sort of like to see, I guess PM10 of course, PM2.5, metals.

MR. MAUDERLY: Just 10 and 2.5, you don't put a size distribution or....

SPEAKER: I'm trying to do this in a rough order of sort of my own sense of priorities.

MR. MAUDERLY: Okay. Yeah, he's prioritizing.

SPEAKER: Ultra fines. Particle number, free floating oxidants. Giving my sense of the sort of equal priority of gases and particles, I'd stop my

list at PM characteristics here and emphatically add ozone, C0.

SPEAKER: Same levels?

SPEAKER: Yeah. N02, slightly below that S02. Then I'd add temperature, barometric pressure and some measure of water content RHO. I think you're going to get a decade long time series of these measures, we have on the monitoring side a real good sense. I would also propose, back to Item #4 on your list, one of my pet sort of things that I'd try to push. I think it's conceivably doable, and it ought to at least be seriously considered, to document the health benefits of changes in pollution exposure, reduction of pollution exposures, how they come about, primarily by standards. And we ought to note carefully the changes in both exposure and health that these standards bring about. I would therefore propose in some locations at least they continue measuring these same things at a somewhat reduced frequency after 10 years. I would submit that this would be a nucleus. There's just as much premium, in my mind, on sort of from a time series study point of view, a full time series of a relatively limited repertoire of things as there is a premium on a massive number of things, that you run a high risk of running out of budget to do after a couple of years.

MR. MAUDERLY: Well, you've raised

some sort of ancillary issues. You raised the issue of looking at improvements, you raised the issue of budget, applied politics and all this sort of thing. But the core issue is you listed about four characteristics of particles there. And you're positive that you would be happy with that from your standpoint. That's fair enough. That's fair enough.

SPEAKER: Point of clarification. You said PM10 and PM2.5, is that mass only?

SPEAKER: I'll stick to my story and answer yes.

MR. MAUDERLY: Now Rick, I'd be interested in your, starting with this list now, he's been bold enough to throw something out there to shoot at and we've got a dart board now. Can you put an overlay on that? Can you take off from there and add or subtract and fine tune priorities from your viewpoint?

SPEAKER: Well, my skepticism with epidemiology is we're only then bringing correlations, and each of these, you know, the reason I like PM coarse or fine or ultra fines is not because of particle deposition, but because I think they measure a different source and therefore there may be a different signal coming from those series. So, some size fractionation. I'm not completely obvious that particle number is all that important. But I think, it seems the particle number's highly correlated with mass of the

ultra fine.

MR. WESTERDAHL: What would your cutpoint for ultrafines be?

SPEAKER: Well, probably somewhere under .1.

MR. WESTERDAHL: You might want a smaller one.

SPEAKER: The metals, you know, I don't know, I think that's a big can of worms. You have a lot of data... I can always find some association if we have metal data. Obviously from what we've seen the other gases are important... So, I think more of what do these things represent in terms of pollution sources or mixtures or whatever, because I think they're all really, probably going to be a surrogate for something that you or I understand is happening. So, I don't really believe that any of these things, that we can pretend to see a statistical association without conducting a cause and effect.

MR. MAUDERLY: But remember your job, Mr. Health Scientist, is to try to answer the question about relationship between airborne particulate matter and health. That's sort of the job.

SPEAKER: But I...

MR. MAUDERLY: What are the particle tools that you want to do that job?

SPEAKER: Well, size fractionation

is probably the most important one.

MR. MAUDERLY: But you're saying you're not really interested that much in speciation composition?

SPEAKER: Well, maybe a little bit. Maybe the elemental carbon, but, you know, I think we'd see a signal probably from diesel sources. If we could actually measure some marker of diesel source pollution.

MR. MAUDERLY: Yes?

MR. HALES: I kind of like that list, but I put together another one myself during the break and it captured something this list doesn't. I just wondered if we could take the time to look at an alternative list?

MR. MAUDERLY: Certainly.

MR. HALES: What I did was I based this on two intended uses for this network for health effects. One is direct testing of health effects on crops, but I don't know how powerful these six or so stations are going to be at doing that. But also, the second thing is, examining the co-variability between routinely measured variables and more exotic species. Because we're going to be measuring routine variables at a lot of places around the world, and knowing the correlation between those you're attempting to measure seems to be an important thing, in my mind at least.

One of the things this doesn't capture is the independent variables that can exist. To me, it's become apparent here that we probably need to think about that a little bit more. So, my first one was PM2.5 mass, organic carbon and elemental carbon. We're going to, everything, right, and make it all just organic carbon, total organic carbon right now because we know speciation is going to come up. And I could do the same thing for PM10, put it in that order, PM2.5 and 10 mass, organic carbon. #3 I would get into some size segregated emphasis that was brought out a little bit later, and what I would do is recommend a packer sampler that would give you maybe seven cuts between 500ths of a micron and 20 microns, and maybe seven divisions and doing metals, because they're easy to do with x-ray fluorescence. You certainly want to do sulfate and you want to do hydrogen ion, but you're going to get some size distribution information out of those, and I think it's probably going to be important...

SPEAKER: What's the third one?

MR. HALES: Metal sulfate and acidic.

SPEAKER: Can I just ask a question for clarification? What I was proposing would have been for not the super sites, not a very limited number of sites, but an upgrade if you will, of a goodly number of sites at a lower level of this tier monitoring.

MR. MAUDERLY: Well, let me ask you a question. Assuming we're talking about super sites, since that's supposed to be the main topic of this discussion, so just saying I'm not talking about those isn't quite fair game. Saying that we're talking about super sites, now you're in the super site, are these still your first priorities? Would they not be? I mean if you're going for a lesser site, maybe that's all you could measure. But even if you could measure dozens of things, are these still your top priorities. Is that an understandable question?

SPEAKER: Health effects studies, yes.

MR. MAUDERLY: Okay.

SPEAKER: I see a lot of merit now. Now they're in the super site arena.

MR. HALES: I've got about three more on my list. It seems to me also that just a physical size, particle size distribution measurement, again .05 microns and about 10 microns is an important thing to do. So, we're talking about electrostatic aerosols that might exist. Physical size distribution, I think we're going to get some insights out of that. Co-pollutants, again the ozone refractory ones, and then down at the bottom of the list, before I go any farther, I guess I started worrying about things like nitrate salts and so forth, ammonium salts, but those are tough

because they require a few meters, it's something...I could go on and on, but that's a list of what I would want to see at the top of the list.

MR. MAUDERLY: Let me go over here to Lucas, who's busy himself recording all this. We've got to get him engaged in this now and say you're going to be doing an epidemiological study. See a couple of cracks here in prioritizing some measurements. What's your perspective on that? Can you buy that?

MR. NEAS: Like Rick I would like a product that might be produced on the basis of modeling that then would be used for the health analysis. If you think of everything that escapes from a tailpipe, they've all got me worried, C0, N02, ultra fine particles, nitrates, they're all going to be very highly correlated. To distinguish between these species in terms of epidemiologic studies is almost impossible. Men who are in toxicology know as much as I do about that. But if I had, if people could use elemental composition or other things doing the day to day variation in the source attributable mass, so what fraction of PM2.5 is attributed to automobiles that day. Then I would take that and measure it against the health effects. I wouldn't be able to distinguish between everything that came out of the tailpipe, but I might be able to tell you the difference between long range transport of sulfates

and locally generated fuel oil.

MR. MAUDERLY: Let me see if I can rephrase the last part of your answer, just to see if I understood it, not that it wasn't real clear. But what you're really interested in is being able to try to source apportion. You're less interested in the details of composition, because they're so correlated, but you're more interested in the source. So, your answer is, whatever you guys have to do to tell me where it comes from, that's what I want you to do.

MR. NEAS: And not just long term average source apportionment, which is really what many source apportionments studies stop at. But day to day variation in source apportionment. That would be very useful. We're trying to rough cut it, using some XRF data. Everyone has told us we're wrong. Well, let's do it right and then prepare a health study. We're trying that, but it could probably be done better with the super sites. But whatever is needed to give us day to day source apportionment mass.

MR. MAUDERLY: Rick, do you buy that? Do you vote for this guy?

SPEAKER: I mean I don't want to put down the epidemiology, but it's not, I don't think sensitive to, you know, tease out these individual little quirks and what comes out of a tailpipe. I mean, I just don't think that we're ever, we're never going to be able

to take really severe health endpoints, like mortality or heart attacks or so on in a large population base and do all the kind of exposure assessment and individual analysis that we'd like to do. I'm just trying to be practical here. What I want in 10 years, is I want to get some hypothesis, potentially at a reasonable level. What I'm concerned about is we just collect tons and tons of data, spend a lot of money and we end up where we are today, with still a whole mess of hypotheses, none of them we can even throw off the table. If I could throw two of those off the table, I think that would be an advance.

MR. MAUDERLY: Well, now let me ask then, Jane, you're a perfect straight person, you just raised your hand, we have had a couple of epidemiological viewpoints here. Now you're in a little bit different realm. You're doing studies of individuals and in some cases you're doing clinical studies or intentional exposures. So, you have a slightly different hat on. Can you work from this? Or Rich will start a third list here. Now we had a list for you before, as to all the things you'd like to know, to do your study on. Can you bring some priorities to that list that you had, in parallel to this, from your perspective?

MS. KOENIG: Well, you know the second list was not that different from the list that I had. Maybe it was just a little more knowledge about

organics. But I think what Rick said about epidemiology, that may be true for a strict time series analysis, but epidemiology doesn't have to stay doing that, it can be doing panel studies in assisted care homes. You can be doing panel studies in children. You can be looking at case cross over kinds of things, with mortality, sudden cardiac death. I think that, I don't think that any of us are going to be restricted to doing time series studies for the next 10 years. I think we're going to be doing what David Bates calls more creative epidemiology and we're going to think of ways...if we have, anybody who has access to a community that has very precise measures of air pollution should be able to devise some health outcome studies that take advantage of that.

MR. MAUDERLY: Let's go back here first.

MR. TOLOCKA: I just have a question that might clear something up for me. Are you health guys interested in mechanism of action, what constituent of particulate makes an ill effect on a lung tissue? Because I think if that's what, one of the questions that you're asking is what is the mechanism of damage or what is the mechanism of an ill effect, and I think that you need to do chemical speciation to know.

SPEAKER: Well, epidemiology is not going to be very well suited. Sure, the answer is yes,

absolutely yes. We want an epidemiologist or a clinical researcher or an experimental toxicologist, everybody is interested in knowing more about what the biological mechanisms are that intervene before the illness or I started to say the clinical health effects occurred. There's another question though that has to be simultaneously addressed and that is, to what extent can epidemiology make a contribution to increase the understanding of those kinds of instances. I'm assuming, Joe, and correct me if I'm wrong, that the focus of this discussion is sort of more what's appropriate to measure in the field.

MR. MAUDERLY: The focus of the discussion is on the advice we give to those measurements out at those sites. The answer is of course we're interested in mechanisms. What we're talking about are the tools. In the laboratory we have finer control over composition, we can play mechanistic games with cells and animals and so forth. So, we'd like to know everything that's out there, so we can sort of put those on our pallet and paint with them and try to figure out what might be important and how these things work. But what you're hearing is, the epidemiologists are saying look, we can't really do that. We draw associations between exposure and effect on a statistical basis. We're not going to tell you what the mechanism is.

SPEAKER: We could suggest mechanisms. I know there are a few toxicologists who try to understand whether that's the...

MR. MAUDERLY: Now there was a hand over here.

MR. HALES: I was just going to approach this problem from another perspective. Let's try a thought experiment here. Say that we were lucky enough or wise enough to choose to measure the variable on our station that was the culprit variable and let's suppose that there was only one culprit variable, so there was a fortuitous combination of events here, and, but we didn't know that, but we did actually just sort of luck into it. Would the epidemiological community be able to use this assisted network to verify that indeed that was the culprit? Is this a robust enough system, even if we were lucky enough to do it, that it could be used to test epidemiologic hypotheses in a realistic point of time.

MR. MAUDERLY: What's your answer, Lucas?

MR. NEAS: Let me give you some other things. You have to perfectly measure, not only have to measure the exact agent, but with no measurement error. You have to have it uncorrelated with other commonly admitted species from the same source. It has to produce a relatively prompt health

event. Then in a panel study, and it has to have considerable temporal variation. Then the answer is yes, but that's a long ways.

MR. WILSON: Before we go to the frequency, I'd like to go back to what we might measure for just a moment. There are two things. First, just little simple things. We know that the hydrogen ion is in the accumulation mode. Why would you want to measure the size fractionation. It seems to me we know the size of the hydrogen ion, particularly since you, it's very, very expensive to measure hydrogen ion in bulk, and to try and measure it on an impactor seems to me not a useful measurement. I don't want to tell the measurement people you've got to measure the hydrogen ion on the impactor, or you'll waste a lot of money. So, unless some health person can tell me why he needs to know the specific size distribution, it's all going to be between .05 and 1 micron and why you need to know it in there, I don't think you need it. So, I don't think you need hydrogen ion there. You need to measure it, but not in size distribution.

MR. MAUDERLY: Well, is the proposition that we do hydrogen ion by size? Is that what this is?

SPEAKER: I'll be happy to remove hydrogen ion from the list.

MR. WILSON: Now I heard Lucas

talk about measuring sources and I heard Rick here talk about measuring things that are orthogonal. The sources are orthogonal. The only way you can figure out the sources is because they're orthogonal, but I think you guys are on the same wavelength, you're agreeing. But the super sites are going to be trying to determine the sources. A lot of the effort is going to go into that. So, if you put up there the daily source contributions, that's going to be very useful to the people who are deciding what the super sites will do. Because they say okay, we're going to measure them for four months a year. But if the health freaks would like to have them every day, we'll do it every day. That will be a great service, because it will get you a data set that hopefully will be useful. So I'll make another list up there and if you guys agree, it would say daily contributions of source types or of distinguishable source types. You can't distinguish all the various source types, but you can distinguish some. Those are the things that are, those are the groupings that are embodied.

SPEAKER: That would be miles ahead of where we are now.

MR. WILSON: And I would just like to go back to why anybody cares about PM10 and PM2.5. I think it would be very important to measure the fine mode separately from the coarse mode. When

you measure PM10, you've got them both mixed up together and you have two things which in many places don't correlate with each other, so they average each other out. So, it's just happenstance that we get PM10 to correlate in some places and correlates in places where there's a good correlation between PM10 and fine or between PM10 and coarse. So, it would be a lot better certainly instead of PM10 to do whatever coarse chunk you can get, 10 minus 2.5 is better than 10, but it would be a lot better to do, whether it's 1 or 1.2 or 1.5 or 1 after you've dried it, but it seems to me it's important to get the class of sources that are contained in the fine mode and the class of sources that are contained in the coarse mode, rather than having part of the coarse mode down in the fine with PM2.5 and missing an important part of the coarse, missing the part that has the highest deposition in the lung. So, you would get a lot better definition for your EPI studies and differentiate whether it's fine mode or coarse mode. If you're going to measure fine mode particles and coarse mode particles, rather than some arbitrary size, which happens to be the smallest size cut we knew how to make 20 years ago when we decided to start doing it.

MR. MAUDERLY: I doubt if anybody would argue with you that being able to distinguish a fine mode from a coarse mode and look at health in

comparison to those two in contrast would be useful. On the other hand you and I both know there's not going to be any super site that doesn't measure PM10. Just PM10 mass, the current standard demands. The sites can measure that, but your point is, and I think it's very good, is that that's fine, it will be there. No site will not measure PM10, but on the other hand what you really want is to be able to capture that coarse mode, the PM10 minus 2.5, see what that is.

SPEAKER: Or minus 1.

MR. MAUDERLY: Or minus 1, yeah. The fine particle standard ought to be PM1, but that's a whole other argument.

SPEAKER: You'll find that the characteristics are different in the coarse. In the coarse the metals seem to be a lot more in the coarse than the fine. There are a lot of different things about that.

SPEAKER: The different kinds of metals and the metals out here.

MR. MAUDERLY: So, your point is well taken. So, somewhere up there, Rich, have you got PM coarse or something?

MS. KOENIG: I'd like to change my list to PMCF instead of PM10. But I'd also like to make it clear that I'd rather have continuous measurements than 24 hour averages.

MR. MAUDERLY: Which is a good segue into the next topic. I think we better skip location for now and get onto measurement frequency, or we're going to find the afternoon getting away and we'll never talk about that. There are some people in the room who I think have some important things to say about measurement frequency. So, unless there's something really grinding on this...yes?

MR. ZIKA: I just had a comment about the PM2.5, if I am correct, and that is that it does make a difference depending on what part of the United States you're in that you're going to see a very different organic composition. Sure, in the southeastern United States it is probably going to be very different than it is in southern California, where most of the measurements, speciation measurements have been made versus the coastline where it's going to be very different again, versus the northeastern United States. Some places you're talking about biogenic composition, for instance in the southern United States of this fine material. If you get into an urban area you're talking about a very different composition. So, is that a good, without doing any speciation studies, is that really going to give you a valid appraisal of what's out there.

MR. MAUDERLY: Well, we had one list that had some speciation in it.

SPEAKER: Well, all you had was OC, EC, which tells you nothing about that composition.

MR. ZIKA: Since I was the guy that made the list, #7 on that list, what I didn't put on was speciated VLCs...VOCs.

SPEAKER: That wasn't on your list though, was it?

MR. MAUDERLY: It is now.

SPEAKER: It was #7.

MR. MAUDERLY: It's been written down here on the floor. You don't see it, but it's there now. Jerry?

MR. ABRAHAM: I missed the beginning, so if I'm covering things that were covered at the beginning, I'm sorry, and you can shut me off. But one of the things that I'm worried about is that we're driven by PM2.5 and in a few years maybe we'll be interested in PM1, maybe there will be a new law that says PM1 is to be measured. If we don't archive samples, even if we're not analyzing them, if we don't archive samples that can be looked at later by individual particle analysis or by other chemical means, maybe gaseous samples can be saved in some way as well as particulate samples on filters, suitable for different kinds of analysis than Teflon filters only, I think we'll be not able to help the epidemiologists who may ask some questions later and they'll say oh, now

we've got to start all over again. So, I think archiving samples for future wide potential analysis would be an important thing I would want in a super site.

MR. MAUDERLY: That's a good point. In fact we didn't talk about that earlier. But the point that samples ought to be archived, to the extent that we can and we think we're preserving their integrity, but which is always a problem over time, makes a lot of sense.

SPEAKER: Can you take your total deposition volume and take that kind of approach?

MR. MAUDERLY: Only if you're not going to take the time to talk about...

MR. WESTERDAHL: Well, the point I wanted to make on this, if we're talking about what we've done in the past, is we've had a TSP standard then a PM10 standard along with a PM2.5 and a PM10 standard, and we always talk about bimodal distribution. You'll notice this is not bimodal... this isn't what's in the atmosphere either unfortunately, but actually is a trimodal distribution or more complex than just two prongs.

MR. MAUDERLY: This is not a distribution conference.

MR. WESTERDAHL: No, it's not, but it just reminded me that in fact in the atmosphere there really are at least three bombs known as cherry bombs,

and we're dealing now regulatory-wise and scientifically with the right hand two bombs, making believe that the left hand bomb is what's atmospheric for ultra fines by number. It's not, but I wonder if we're going to help ourselves. There are many people in the regulatory and scientific community who think ultra fines are very important. So, if we don't measure them with the same kind of characteristics that they didn't get in on the right-handed #2 list, I just wonder if we're going to miss the boat and three or four years from now say gee, we'd hoped we had a routine measurement of this other component that comes from other sources. I don't want it in my own list, but I would kind of wonder if we maybe should add that, a routine measurement of that next mode now.

MR. MAUDERLY: Well, I think ultra fines were on the list, weren't they?

SPEAKER: Not on ours.

SPEAKER: No, they're not on the last two. They were on one.

MR. MAUDERLY: They're on ours.

SPEAKER: They're in the gospel, right here.

MR. DREHER: In terms of the ultra fine issue, I'd like to speak about that because there are some studies, coming back from a meeting in Europe, where there are now Malaysian animal studies

comparing ultra fine particles and fine particles, ultra fines, neutral sulfate versus fine sulfate and there are no effects with the ultra fines. There are metal fume studies comparing zinc oxide human exposures compared to metal oxide human exposures and if particle number and surface area were an issue, you should get similar responses and you don't. So, I'm not convinced that ultra fines should be measured, but I wouldn't put it up there on the priority. We seem to be making wish lists, and I guess what we should be doing is assessing what the current data is, to prioritize some of those measurements.

SPEAKER: At the same time, Kevin, there are some EPI studies out of Holland and maybe other European countries suggesting that something may be going on.

MR. DREHER: But wait now, the proposition, you can't, in the ambient air it's going to be very difficult to separate composition from size, pure size effects versus compositional change. So, the EPI, that's going to be difficult to do that. But in laboratory controlled studies, what I'm saying is that ultra fines are not generating a lot of biological responses.

MR. WESTERDAHL: Well, in controlled studies, none of the PM is.

MR. DREHER: That's not true.

SPEAKER: Well, near atmospheric

levels.

MR. DREHER: Well, no, not atmospheric levels. But we don't know what, in terms of the animal exposure to human exposure extrapolation, what are we exposed to. We have no idea what the personal exposure is. I mean how do we extrapolate? So, I mean that's, so I think ultra fine should be measured, but I wouldn't put it up there on the list.

MR. MAUDERLY: Nobody has proposed that it's high on the priority list.

MR. DREHER: Well, coming from the other group, they would like some priority. I mean we have these 10 issues here.

MR. MAUDERLY: What I'm saying is, nobody in this room, we have done some prioritization, but not as completely as people would like. But on our list, ultra fines haven't been on top of the list.

MR. WILSON: Joe, we haven't brought it up, but at some time you look at the cost of doing things. If it's marginally important, but it's cheap and easy to do, we'll probably do it. If it's marginally important and it's very, very expensive and difficult to do, like size distribution and acidity, then you kick it out. But if it's cheap and easy to do, even if some people don't think it's important, as long as some people do, then you ought to go ahead and do it. If it's cheap and easy...

MR. MAUDERLY: What I want to do now, and we could go on, but in fact it was advertised that this would be over around 5:00. Well, 5:00 is coming up quickly and there are issues that we haven't talked about. We're obviously not going to cover them all today. We'll get another crack tomorrow morning, I guess, to get back together and talk about some things. But one thing I do want to touch on today, before we get away, so let's shift the conversation to that, and that is the measurement frequency business.

Now I know that people like Lucas and people like Rick, you know, that are out there doing studies, understand some of these issues and have some strong feelings about, if you're doing thus and such kind of study, out there in the community, then you require these kinds of measurement frequencies. I'd like for them to talk about that a little bit, because the measurement community needs to hear about that. So, I'm wondering, maybe you could start off and talk a little bit about the different kinds of epidemiological studies one might do and what kind of measurement frequencies, give us a reality check. What kind of frequencies do you really need for this study and that study?

MR. BURNETT: Well, for any acute effects studies you need as acute measurements as you can get. Jean said it would be great to have continuous

measurements, if you were doing studies on lung function, lots of stuff now coming out about heart attacks, when they occur and bimodal phase and so on, you'd like to know about changes in particle levels to date. One of the things that we find is we find distributed effects of air pollution. So, air pollution exposure today and you get people dying for several days or hospitalized for several days. If you had, every third day you missed that signal, episodes also only happen in most places, and last for a few days. So, you're really, not really characterizing the episode impact. So, the acute effect studies, the more temporal tightness that you can get in the data, the better. For the chronic effect studies, I think that you need things like seasonal variability is probably more important. Obviously longer term measurements, chronic effect studies also have the difficulty, if you're just following a cohort that's always exposed to high pollution, you never know what exposure window is really important. So, you almost need people to move around the country from high to low, low, clean environment and move to a higher environment and so on, for seasonal differences or something. So, that's one of the things with the chronic effects studies that's a little misleading, because you think you have, if you have 20 years of measurement, somehow compare that to five years, that there's really some difference going on there, there

really isn't. Because people are being exposed all the time to that kind of pollution.

SPEAKER: Well, what if there's a discrete, relatively large drop in exposure that's come about on one or more standards?

MR. BURNETT: Well, you need contrast, though. You need other people not to have that experience. If everybody gets that experience, you're back to the same place.

SPEAKER: What if you follow them a long enough time and you get a certain time window before the standard goes in and compare it to that same city after it goes in.

MR. BURNETT: Looking at longevity, they only die once.

SPEAKER: But aren't there other potential health measures that could be studied...

MR. BURNETT: Sure, development of disease and I think you still need, you still need some contrast, epidemiology is contrast.

MR. MAUDERLY: John?

MR. BACHMANN: Yeah, I just wanted to poke the time series question a little bit and see what the minimum time window for diurnal might be. You have access now, you've done a lot of studies like this to gaseous pollutant data, which is pretty close to continuous. Do you tend to, just because of the amount

of data you have to manipulate, do you tend to take the hourly averages, because they're available and not the continuous measurement, or do you take them because, don't take them because they're not available? In other words, would you care, would you see much difference between hourly and really continuous?

MR. BURNETT: Well, it really has to do with the correlation between hourly averages and continuous data, which is usually very high. It has to do with how you're sampling your health input. If I'm doing daily hospitalizations and it's really the symptoms started a few days ago, like with asthma attacks or something like that, then sort of knowing that what was the particle loading at 3:00 o'clock today, when really the, or a couple of days ago it didn't make much difference. The only pollutant that we find a little bit of a difference is like ozone, where people tend to spend most of their time outdoors in the afternoon. When we do time activity studies, ozone peaks in the afternoon so there's a correspondence there, and we tend to find one hour max ozone to be a little bit better predictor, not a lot, because they're correlated with eight hour and daily averages. C0, N02, there are sort of two big peaks in the day, it sort of doesn't really matter that much. Again it's the crudeness of the study. If you have the health measurements are on a daily basis, it doesn't really give you a lot, if you have

very fine exposure measurements. You have to match up the health measurement timing with the pollution measurement.

MR. WESTERDAHL: Just one expansion of that, if you were doing an asthma panel study or a cardiac panel study, watching individuals over time, you very commonly would want to know differences in say lung function in the morning versus lung function in the afternoon, peak flow in the morning and the afternoon. If you're going to do that, then you need this time resolution to correlate what was the past eight to 12, 24 hour, what, the previous 12 hours maybe, time frame. So, it depends again on what question you ask.

SPEAKER: The difference between the Uniontown and the State College panel studies turned on the fact that we went from 12 hour particle strong acidity measurements to 24 hour averages and that really blurred out the sort of immediate impact of particle strong acidity. But that's on a panel study where we had a physiologic measurement, where you had direct access to the subject. With the time series studies of mortality or hospitalization where you're dealing with found data, this is data in some administrative records system, there's such an end game associated with mortality. There's the smearing out between the insult and the event that you're

measuring and that's got to blur the time course. So, for mortality and hospitalizations, I don't know anyone that has done much more than the daily, you haven't segregated them by time of admission.

MR. BURNETT: And the thing is you spend 12 hours in the emergency department before you're admitted anyway, so...

MR. BACHMANN: But this is a pretty important insight. It means that depending on which kind of short term study you're doing, if you've got a panel study, you may really be able to use, a summer camp study, you may really be able to use this kind of time resolution and you should. In the other cases it's not so clear it's necessary.

MR. WESTERDAHL: And in fact the super sites, to the extent they may be useful to support health studies, they might be most useful, or they could only really be useful to support the sort of studies where you go in and follow population intensely for a while, because the super site is not going to be there forever. You can't do long term time series studies. You could do a camp study, you could do a panel study nearby and that's where the time resolution by about at least 12 hours, probably the maximum you could put up with.

SPEAKER: You could do it with people with Halter monitors. It might be minute by

minute, you know.

MR. MAUDERLY: Is it possible to frame what you guys are saying by a list? I mean Rich has got acute and chronic. Are we really talking about sort of three major categories of studies? A panel study, a daily mortality or morbidity study and chronic studies? Does that make sense or are there four or six or those three? So, can we get those three headings and then give us your one liner, as to frequency that you can tolerate for each of those. For instance...

MR. NEAS: Just put time series, by that we'll mean the mortality, hospitalization. Panel/acute and then chronic.

MR. MAUDERLY: Now for chronic, for instance I've heard mentioned, well, we'll collect data and we'll measure every six days or something like that. Now if you just limit your perspective to chronic outcomes, then is that any better than once a month or what can you tolerate in terms of chronic study, if we're looking at sort of the minimum measurement scale?

MR. BURNETT: Well, the, I think the analysis goes that the, you know, if you're looking at the air through an annual means, they really start to go very high, don't they? I don't think you have less than one in six days, I mean. I haven't done a lot of work in that.

MR. NEAS: In the 24 city study it

was every other day. Every other day I think also in the six city study, every third day strikes us as being, making, when Petros said this morning, we're going to do speciation monitors every third day, there was a gasp in the health community because that time series and panel studies are now out. Speciation monitors would be only useful for chronic studies.

MR. MAUDERLY: Okay. But my question is not whether or not once every three days or six days will serve the first few purposes, but starting at the bottom, what's the lowest frequency you'd be comfortable with, just from a chronic study viewpoint?

MR. WILSON: Well, I guess I don't know any person who's looked at that statistically.

MR. MAUDERLY: Okay. What's the answer?

MR. WILSON: And if you're doing something which is relatively even from day to day, like PM10, you probably, one in six days will give you plus or minus 10 percent. If you're looking at PM2.5, it's going to be plus or minus 12 percent. If you're looking at something like a metal or sulfate or acidity, it can be from 20 to 40 percent error, one in six days.

MR. MAUDERLY: How much does that improve when you cut that in half to three days?

MR. WILSON: It gets some better. But when we looked at acidity, which is one of the worst

ones, a number of years ago we decided we had to do every other day to get down to five percent error. Now for PM2.5, it may not be that bad, but the question is, if you want your data, you know, to do chronic studies, or to do long term trend studies, why not collect for a week instead of every six days, or collect for a month and you don't have nearly as many samples, since you're not going to be able to use it for a times series anyway.

MR. WESTERDAHL: I was going to suggest a controlled health study in southern California and we're running a two week continuous sample. Even with that, so we're getting a continuous measure that we can either look at seasonally or annually over a 10 year period of time. That produces a fairly robust measure, if you weren't missing any events. So, often these are annual averages or seasonal average sorts of accumulations for chronic studies.

MR. MAUDERLY: If you're measuring for two weeks, at what frequency?

MR. BACHMANN: No, no, continuously.

SPEAKER: Sample every two weeks.

SPEAKER: Collect for two weeks one sample continuous.

MR. WILSON: Yeah, two week integrated sample. For the next two weeks, you get

another two week integrated sample for the whole week, so you've got 26 samples that integrate all year.

MR. MAUDERLY: But you're operating the monitor continuously.

MR. BACHMANN: Instead of turning it on for 24 hours you're turning it on for two weeks.

SPEAKER: You heard Petros, what the panel that looked at that for another purpose concluded, that there were some concerns. Some of those concerns go away because this is a separate rationale, some of them don't, and one of them I would submit to the community here, since we have a lot of atmospheric scientists, is the integrity of the sample over two weeks. How comfortable do you feel, you probably feel pretty comfortable for some metals. How comfortable do you feel about organics and some other aspects?

MR. WILSON: Not at all. More comfortable than I feel about the 24 hours after you've collected on Teflon.

SPEAKER: Obviously that's an issue.

SPEAKER: You have to use something that will absorb the species that are semi-volatile.

MR. MAUDERLY: I would've thought that all you measurement guys would've jumped up and

screamed about a two week sample. We made one nervous, are the rest of you asleep, or are you agreeing that those are okay?

SPEAKER: Yeah, I'm nervous.

MR. MAUDERLY: We have two nervous.

MS. KOENIG: Well, the organics are really a problem. They wouldn't, they need to be kept at low temperature.

SPEAKER: But if you absorb them on charcoal impregnated filters, they probably will stick.

MS. KOENIG: It depends on the species and what you're trying to do.

MR. MADDEN: There's also a problem with the co-pollutants like ozone coming in and oxidizing and destroying their...

SPEAKER: You may get a problem with the mechanics of the pump continuing to operate.

SPEAKER: Well, we've just heard that they've been run for two weeks.

MS. KOENIG: It's certainly useful for some species that wouldn't be conserved, but obviously for mass it probably...

MR. WILSON: You certainly could test it and where we've tested it, it's been all right. It hasn't been tested yet for organic. My contention is that you can save the stuff that way as well or better

than it's being saved on the one and six day filter, which stays out in the field for several days and then it's carted around and stored for a month before it's equilibrated and weighed.

MR. MAUDERLY: So, you guys, are you comfortable with this idea of a two week integrated ...we're talking about chronic.

MR. NEAS: I would be very suspicious of any epidemiologic study based on the super sites to look at chronic health effects. Not because I think that six is too small a number, but because I don't believe that you're going to have a gradient. You're picking six dirty areas, they may have different pollution characteristics, but we're not talking about chronic for super sites, we're talking about chronic for the 50 speciation sites. So, we have broadened it.

SPEAKER: Oh, good, you're done with it, that's clear.

MR. NEAS: No, it's not clear. Because with the six super sites, it would be hard to hang a chronic study on that when we have sufficient gradient across just six.

SPEAKER: Oh, I agree. I agree wholeheartedly.

MS. KOENIG: Well, I just came from...I just came from that group and they're going to

recommend super sites in some clean areas, so.

SPEAKER: You're not going to put one of these super sites in Topeka.

SPEAKER: Why not?

MR. BACHMANN: Because there's no PM problem there and the other objectives weren't met there. There's no PM problem in Topeka, they don't violate the standard, your number one objective is not all that exciting to people, if you don't have a pollution problem to study. Now there may be some clean places that people want to study, that is in the middle of the CO sulfur or something like that, but I would tend to agree that the super sites, if we have seven of them, that we will not run seven of them long enough to do a chronic study in all seven. We might run a fewer number for a longer period of time.

SPEAKER: But what is your concept of how long these will sort of run?

MR. BACHMANN: I think it's probably less important to figure out what the bureaucracy is going to do or not do there, than to get the ideas of the health scientists. If you were going to do a chronic study, what are the key things you're looking for. I've already heard, you know, and some things are going to fall into the super sites, some will fall into other categories. If we're hearing that chronic could live with a good long term average, but it has to

be seasonal, then it's up to me, to me I think it's up to the atmospheric scientists to figure out how you get a good long term average. Is that a two week sample, or is that one every second day or whatever? That's what we should hear, not worry about which side is going to be funded, I think.

MS. KOENIG: Well, I'd like the health community to think about whether they really want to always be, do we want to only be able to look at chronic studies with integrated samples? What if it's the peaks that are?

SPEAKER: It could be the peaks, and that's a good point and that's the reason for you to carry them. You would carry them.

MS. KOENIG: And we'd never find out.

SPEAKER: A place that had lots of peaks day to day, you might miss them two weeks. But there's the other sampling going on too.

SPEAKER: That's a possibility as well. You could have a continuous mass monitor that was very cheap to go inside and you would find out if you have peaks.

MR. ABRAHAM: If the super sites are being decided to not be for chronic studies, why did they have to be at fixed locations? Couldn't there be a mobile super site to...

SPEAKER: We haven't said that, that that's absolute.

MR. MAUDERLY: But the location is the third one we skipped over, so we could get to the fourth one. In fact it's been proposed in this document, at least in one place I read, that there be mobile points and I would certainly vote for that. I'd even argue that.

Well, let's go back then. Can we summarize chronic in some way? You've got to have seasonal variation, right? You might do it by a two week integrated sample. If you're going to take 24 hour samples, people seem pretty comfortable with doing that every three or six days.

SPEAKER: Can I ask a question about the long term average?

MR. MAUDERLY: Yes.

SPEAKER: As a non-health person? In the ozone issue, at least as it relates to plants, for example, there's some indication, and I know plants are very different than humans, there's some indication that actually it's an accumulation of episodes. So, it's an accumulation of hours where the concentration is high. If you simply do a long term average, basically you miss the fact that there were periods of time when the organism is exposed to high concentrations.

MR. MAUDERLY: That was Jane's

point.

SPEAKER: So, would you lose that information and it's chronic, it ends up with a chronic problem, would you lose that information by going with these long term averages? You'd say oh, the concentration is only 10 micrograms per cubic meter, but in fact there were these periods of time when it was 20.

MR. WILSON: Would you lose any more information than you're losing by one in six days? So, I'm not suggesting that we shouldn't have a continuous monitor there for some of the things. I'm just saying that for chronic epidemiology, instead of doing one in six, it would be better to do one integrated sample for two weeks.

MR. MADDEN: You'd lose some endpoints but not necessarily those.

MR. MAUDERLY: Okay. Well, now I think what I heard on the panel studies was an argument that you had to have twice daily samples, 12 hour samples. If you don't have 12 hour samples,...

MR. BACHMANN: I heard continuous to hourly.

SPEAKER: For panel, we're talking panel.

MR. NEAS: I think that for physiologic measures, you know, on a very sudden

reaction to, you know, John Dawinsky and his dogs talking about a two hour break window. The epidemiologic studies may be able to consume as much information as you can give us.

MS. KOENIG: Yeah, if you have a continuous sampler, then you can choose your....

MR. BACHMANN: That's something that seems to be desired and I suspect that's doable. I was probing the question earlier to see what's the smallest you really would like to see. It sounds like to me hours was, might be satisfactory, continuous is a little bit too hard.

MR. WILSON: I'd probably end up using eight hour, 24 hour averages, but I'd want hourly just because I'm...

MR. MAUDERLY: Well, this whole issue of peak, exposed short term peaks, peaks that occur over, you know, the minutes to hours time frame is an issue that to my knowledge is sort of left on the table, it's largely unresolved. It's been raised several times and people can say, duh, maybe so, but we don't know much about it.

MR. BACHMANN: I had hoped one of the values of what we're doing with these things, would be to find out how common the peaks are. We don't even know that.

SPEAKER: One of the things we

should be aware of is that as you go to shorter and shorter time averages, and you're looking at more and more short, large episodes, excursions, the spatial variability very likely increases and it's not clear that this peak that you see here is temporally correlated with the exposure several, a kilometer away, although there might be a similar peak, it might just occur a half hour or hour later. So, you've got to really think that through.

MR. NEAS: You mean waves of sulfate?

SPEAKER: A few particles can cause you a spike that means nothing really.

SPEAKER: So, you've got to be real careful when you start looking at short term averages and peaks, to understand what that really means, in terms of a larger exposure.

MR. MAUDERLY: So, Lucas, Rick, are you satisfied with what's up here under panel studies? We're talking continuous, as an ideal situation. We've got one to two hour averages up there, you get that from continuous. You lose quite a bit if you go anything less frequently than that. That's where you want to hold out on panel studies.

MR. NEAS: I assume that if you're collecting continuous information, you'll be able to integrate that.

MR. MAUDERLY: Well, it's true. If you collect continuous, you get everything you want. I guess what I was trying to pose is, let's say you decide not to do that, then what's the next step down the list?

SPEAKER: And for anything that you have to measure by collecting on a filter, to take back to the lab, you can't do that, those measurements continuous. So, it is pretty important to specify, because you may want to look at some pollutants in your acute time series studies that you can only analyze by filters.

MR. CREASON: But if you're carrying filters back to the lab, you have to have 24 hour filters. A lot of these places with 10 or 20...

SPEAKER: Well, there's this long history of source apportionment studies being done with 12 hour samples, but for some reason everybody now is thinking about these speciation sites as 24 hours and there really is a big day/night difference in the levels of pollutants. I don't think any of the health people here can probably say yet, because I don't think we have any publications. But it certainly would be interesting to look at the day/night differences. If I was saying what I'd like, I'd like to see, for those things that had to be collected on a filter, at least consider for the time series that we need, panel acute 12 hours.

MR. WILSON: 12 hours is doable.

SPEAKER: But it would be better to do it in terms of the way the atmosphere behaves, and we don't have time to go into that. But let me just mention that there are techniques where you can measure all the elements that you'd ever want on a strip of filter. You can run one strip of filter for a week and get half, hour or half hour measurements on all the metals, including the elemental carbon. The carbon that's in there, as carbon. So, you can get all that stuff and just cross, but if you're running a two week or even a one month panel study, you might as well go ahead and get all that kind of detail. You may not be able to afford that for a whole year, but the source apportionment people are going to want better time resolution too. Certainly we have seen, when we've had day and night day, 12 hours or six hours, you can get more of your orthogonal sources showing up and that's because the, when your night time inversion layer sets in, you're dominated by local sources. During the middle of the day when you've got a lot of mixing from up high, you're dominated by regional sources. So, you need to look at those two separately. It may not be exactly 12 hours.

SPEAKER: Should we start studying night time people and day time people?

SPEAKER: But there is evidence that deaths from heart attacks occur more often when people

wake up. Now what the relationship of that is to the pollution during the 12 hours before when they were asleep, we don't know.

MR. MAUDERLY: Just goes to show you it's dangerous to wake up. Let's go now to time series, just for a moment.

SPEAKER: Before we leave panel or acute studies, I'd like to point out that very successful panel studies that run with four week periods are short intensive long term. Very long time spans are not necessary.

MR. BACHMANN: The interesting thing here is I'm seeing an awful lot of overlap between the kinds of characteristics we see for like SCAQCS type intensives and panel studies. That is a real great match between super sites and these kinds of studies. They don't go on forever, they're short term, intensive, it's a great match.

MR. MAUDERLY: And your point is well taken. Panel studies don't have to go on forever, not like a chronic study. Now if you folks were going to do time series studies, sort of daily mortality, morbidity, whatever, and if that was the only thing you were worried about, then what sort of the least sampling frequency would you have to have? 24 hour average? That's a no brainer, right?

MR. BURNETT: As Chas pointed

out, 10 years. You need long periods. The other thing is, there's a new type of study coming on the horizon, which are these mid frequency studies, these Harvard students and Amsterdam students are looking at two week, one month, three month averages in air pollution and mortality or hospitalization. So, we're really, because the acute studies are looking at the high frequency signal and now there's a suggestion, which David Bates has been making to me for years saying, Rick, you're filtering out all the real information, and he'd yell and scream. And I'd say, well, David, we want the acute effects. But there is now this body of evidence coming out about these mid frequency associations. So, this is sort of, I don't know if you call it a sub chronic or a semi-acute...

MR. MAUDERLY: What's the time frame they're talking about?

MR. BURNETT: Well, they're talking about several weeks or several months. Basically if you're in a period of several months of high pollution, that correlates to several months of high mortality.

MR. MAUDERLY: Sort of between a month and a year?

SPEAKER: That's the order of the effect. Instead of yesterday's air pollution producing effect today, it's the average air pollution over several weeks affecting mortality for several weeks. But the

problem with all of this is that when you move to the time series, you have count level data. It's dominated by the puissant variability. You need a long series, even if you're looking at these, just that mid range frequency, I've seen these studies done, but they're done in a fairly lengthy time series. So, what we need is visibility of the measurement.

MR. BACHMANN: What, five to 10 years?

SPEAKER: No, eight years in Philadelphia is great.

SPEAKER: Michael was talking about the...

SPEAKER: I don't know, you'd have to go to a two week averaging period. With respect to that kind of data, there's a study...

MR. BACHMANN: That's what HEI is doing right now, whatever it's called, the latest, the 100 city thing? They're looking at the...

MS. KOENIG: At the mid frequencies?

MR. NEAS: Yes, John Samet has a statistician looking at that. Analyzing the frequency domain. The Germans are looking at it, Joel is looking at it.

SPEAKER: Is he using your data?

MR. MAUDERLY: Okay. Well, let's

do this. Let's quit for today, and we'll summarize a little bit of this and we'll be coming back tomorrow morning. We'll be getting together tomorrow morning, to see if we've sort of got it right, in terms of the extent to which we can synthesize this. We have one more argument left to argue, and that is location.

SPEAKER: Real estate.

MR. MAUDERLY: Real estate. What's everybody's pet approach to locating these things and the relative value of mobile versus fixed sites. If there's a particle in the middle of the forest and no one hears it fall, does it exist, you know, that sort of thing.

MR. BURNETT: There was a suggestion from the floor that your American dollar goes much further in Canada, so...

SPEAKER: Please don't make us testify that we spent all our money in Canada.

MR. MAUDERLY: Okay. Well, thanks a lot.

(**WHEREUPON**, the Breakout Group Session was concluded at 5:20 p.m.)

C A P T I O N

The Breakout Group Session in the matter, on the date, and at the time and place set out on the title page hereof.

It was requested that the Breakout be taken by the reporter and that same be reduced to typewritten form.

EPA/NARSTO PM MEASUREMENT RESEARCH WORKSHOP

"Breakout Group; Health Effects"

July 23, 1998

MR. MAUDERLY: What we want to do this morning, there were four issues that we wanted to deal with yesterday, and we worked our way pretty well through three of them, and I want to start off this morning, not by recapitulating, probably invented a new word, that might be what we do, recapitulating what we did yesterday first so we get involved in another, you know, endless argument about these things. Which is great fun, but probably no the best use for time. Let's get onto the fourth issue and kick that around a little bit, and then we'll go back and I've sort of summarized with Lucas and Rich's help last night what we distilled out of yesterday's discussion, and I'll show you that as a reality check to see if we're still on target. The fourth issue that we did not talk about in any substantive way yesterday, let's see if we can get this thing to work, and that's the one that's listed third here, and that's the siting of measurements. We talked about frequency at the end of the day. We spent a lot of time talking about what is the hypothesis and whose hypothesis are you talking about, and we worked on a list of P, PM characteristics. That proves to be very difficult because the important characteristic is in the

eye of the beholder, but we can kind of frame a half a dozen or so that sort of our most dos. You know, every kind of study must have and beyond that, it really depends on what you're interested in. Let's talk a little bit about siting. Now some of the issue with siting, you can talk about siting in different ways. I mean, one thing that I'm interested in some opinion on, I have an opinion myself, but I'm interested in other peoples opinion on, is the sort of deployment of fixed versus mobile sites. I mean certainly there's a number of people that I've heard repeatedly over the last year from the health community talk about how it just doesn't make any sense to have only fixed sites, and they have some reasons for that, and that's because they want to study localities and they're not convinced you can pick four, or six, or eight, or twenty cities and that's going to give you the answer. But let's kick that around a little bit as an issue, fixed versus mobile, and then to the extent that there is opinion that discusses if you're going to have a major site that's going to be deployed for a length of time and we're going to spend a lot of money there. How would you approach selecting either individual locations or regions of the country. How would you begin to divide that up from a health perspective? What would be the drivers there, so let's kick those ideas around a little bit. Now I've been asked by the good folks in the back who are trying to

get all this down, and we all wish them luck, because we don't even understand everything we say, they've asked that the first time at least that someone makes a comment that they introduce themselves, and after that they've got you committed to memory. They're wonderful people and they'll get all your names right from there on. So when it shows up when you're subpoenaed to support the comment you made, they'll have your name right. By the way, my name's Kevin Dreher, and I'm from EPA, so everything I say is charged to his account. Yes, Kevin.

MR. DREHER: Yes, Kevin Dreher, EPA. Looking at your break-out issues there, one trivial but important issue in terms of toxicology maybe that we have, is new technology, and I don't see this. New technologies from the stand point of getting particles, collecting particles in a situation where we maintain most of the constituents, and I see these as real broad, you know, priority issues, but that also, if we're going to interact with supersites, it'd be nice to have a new technology issue there that could help or make an impact in the long view.

MR. MAUDERLY: Yeah, that's an important second level issue. There are a number, actually a number of process or technology issues that are going to be important to sort of, and I certainly agree. Now we did mention yesterday the idea of

archiving samples, and that's one way of getting at what you're talking about.

MR. DREHER: That was sort of a common thing also in the measurement area. How are they going to archive samples?

MR. MAUDERLY: Then there's the sort of real time, on-site issue that you have a particle concentrator. Is there any way to do better than a particle concentrator that just concentrates a certain size range of particles and then nothing else that it's in the air. So I would agree. There are a lot of technology issues that are important to address.

MR. DREHER: But something in the information we send out in the discussion I think that new technology's certainly, you know, one of the higher priorities second level kind of concerns.

MR. WILSON: There are a lot of things that would be nice to do given, but that is a health lab responsibility, not OAQPS or a SIPS responsibility.

MR. DREHER: When I look at this, the supersites is a health component. Not only as a SIPS, you know. If it's 90 percent SIPS, then, you know, the issue here is that we need the benefits of health and monitoring and atmospheric chemists.

MR. WILSON: Right, right, but integrate, not just into your job.

MR. DREHER: Well, I don't know, I mean, measurements you have to collect particles. I see it as a dual function type of thing.

MR. MAUDERLY: Well, it's a, you know, by the way, this is William Wilson up here. The second fellow who gets subpoenaed for his testimony is William Wilson. Is that true? I'd be interested in some opinion on that. To what extent are concentrated particle samples or archived, either particle or organic or whatever samples of value if there were no health community. What value are those samples? Are they any value from a measurement standpoint, from an atmospheric characterization standpoint? Because I've never heard anything driving it except let's have a way to get these things in the laboratory and look at them later.

MS. KOENIG: Well, I guess I'd like to ask William Wilson, we've been hoping that we could use TM filters which end up being an integrated kind of sample over time, to do health, tissue culture kind of studies, and I'm wondering if that would also be, would that be a way to look at, to identify seasonal variability, using that kind of multi week sample?

MR. WILSON: The two problems with the TM; one is you have a tiny little bit of stuff which strikes me as probably not enough to even do tissue culture.

MR. MAUDERLY: What do you mean by tiny? Put it in a framework.

MS. KOENIG: Well, you get quite a bit off after awhile.

MR. MAUDERLY: A couple of micrograms, a couple of milligrams. What do you have?

MR. WILSON: A couple of micro, well, you have a flow rate of what is it, a couple, a liter a minute.

SPEAKER: It's about three.

MR. WILSON: It's three liters per minute.

SPEAKER: Three liters per minute.

MR. WILSON: So instead of collecting a hundred micrograms a day, you'd be collecting, isn't that a sixth of that? So you might have twenty micrograms per day on a little bitty thing, plus you've lost all of the volatiles, sem-volatile, all of the ammonium nitrate.

SPEAKER: Right. That's the issue.

MS. KOENIG: But you've lost that on any filter by the time it gets into the lab for analysis. Isn't that right?

MR. WILSON: That depends on how you're going to extract the material. I would think if I were a health scientist, and I wanted samples for doing something with, I would devise my own technique for

collecting what I wanted, and put it out in the field and do it myself.

SPEAKER: Well, that's what I mean. I mean the supersites can do the air monitoring. You can bring your instrument to these supersites, and they can tell you what's in the air, and you can assess your instrument.

SPEAKER: Right, right.

SPEAKER: I mean, that's what I'm talking about. This interface of using supersite interactions with testing new technology for health effects.

MR. WILSON: I'm sorry. What I didn't understand, I think it's very appropriate on this, you know, John Bachman isn't here to tell us what the supersites are supposed to do, and so I brought that up. An important function of the supersite people see is providing a platform for new technology. They would not see it's their job to develop a big sampler that would collect massive amounts of particles for health studies. But they would be quite happy to provide a platform for you to do that, and provide you with chemical composition.

SPEAKER: That's what I'm saying, because it's very expensive to do the monitoring by yourself, to assess your own instrument.

MR. WILSON: I think that's fine to

say they provide a platform for the health community to bring in their sampler to collect massive amounts of samples for various things and to provide them information on what was in the air. That's fine.

MR. MAUDERLY: Good point. Lucas.

MR. NEAS: I hate to interrupt this discussion to call the orders of the day, but from what I've understood over the last little bit, where the health people and the exposure people are not that separated in terms of what to measure or how to measure it. We're really separated on where we would like to see the supersites located. There seems to be a vast gulf between where the health people would put the supersites and where the air monitoring people have proposed yesterday and in the written documents to put the supersites. I really think that we need to move on to the location, because this is our last shot, last best shot at having input into the location of these. We'll find one in New Orleans if we're not careful.

MR. MAUDERLY: Well, Kevin raised a point, and I think it's a good point, and that is that he's not proposing that all supersites get in the sample collection business, and you back up with your truck, and they'll load in hundred pound bags of particles for you, you know, on demand at preferably at, you know, 25 cents a bag. But that those sites be accessible to the health community, and say, you know, let me put my

sampler while you're doing this. I'll collect a sample. You'll tell me everything else you know about PM. It's a very reasonable thing. Well, let's do get onto the subject. In terms of the schedule, the schedule gives a few minutes this morning to rethink what we did yesterday, and then it has this long rest of the morning for the team leaders to put together the thoughts, I guess. Since the team leaders have summarized their thoughts from yesterday and this group is so focused that by the end of the discussion, we've have our thoughts today summarized, I don't see that time barrier as a limit, basically we have until noon as far as I'm concerned.

SPEAKER: We're not getting back together in plenaries this morning?

MR. MAUDERLY: Is there a plenary scheduled this morning?

SPEAKER: Yeah, we have until 9:30.

SPEAKER: It says break-out discussion leaders summarize, oh, that's a plenary.

SPEAKER: Show and tell.

MR. MAUDERLY: Well, like Lucas says, we've got to move right along.

MR. NEWMAN: I'd like to comment on the use of mobile facilities. I assert that our parking lots are full of mobile facilities that don't get mobilized into the field, and I would argue against the

design of mobile. They become, exactly why they don't get used, is not really clear, but I think what happens is they get so big, they're not something you just drive, they become a multi-wheeler trailer, and it just don't get moved and deployed as you might hope that it would be. I think you're better off investing your money in fixed sites.

MR. MAUDERLY: Well, that's an interesting comment. I mean, you're positive that there are dozens of these sitting around, not being used.

MR. NEWMAN: For different purposes. .

MR. MAUDERLY: EPA people that I talk to are envisioning, in fact, 18 wheeler vans with labs in them that don't move everyday, but they can be moved to Location A for a period of time and Location B for a period of time.

MR. NEWMAN: Somebody ought to look at the experience that people have had with that sort of thing and see whether they ever get...

MR. MAUDERLY: And what is the reason that that's not working?

MR. NEWMAN: I think it's just become too difficult, too awkward to do, and it's not a trivial operation to move. I mean, it takes, it takes a major effort. You've got to, you might take a week, two weeks to establish your site, then you move it.

MR. MAUDERLY: That sounds reasonable to me.

MR. NEWMAN: It's okay to contemplate moving, it's okay to contemplate moving vehicles when you're going into an intensive area, but my experience has been that they don't get moved. I remember the EPA had their vans that never got moved. We have mobile vans that we've seen a dozen parked at the EPA.

MR. MAUDERLY: Now, I'll grant that that's true. I haven't seen them, but I trust that you could show me these vans, unused vans with the wheels rotting on them, okay. Given that, are those equipped to do the kinds of things we're envisioning here?

MR. NEWMAN: No, they were made for supersites of their day.

MR. WILSON: That were, you know, equipped for the same size stuff you're talking about....

MR. NEWMAN: When William and I agree on something, you better take heed.

MR. MAUDERLY: No, that makes me very nervous, when you agree on something. You had a comment down here.

MR. MADDEN: One thing I haven't heard discussed at this meeting is the heterogeneity of these measurements within the site. In other words, I don't know how different things are within, let's say,

New York City, okay I mean, there's some reason to speculate that people upwind of a greenbelt for instance are going to get a higher dose than people downwind from greenbelt. Is that really true? I mean, that's been proposed. If that's the case, if there is large heterogeneity within a supersite, a supersite area, I would propose needing a mobile unit as opposed to a fixed unit.

SPEAKER: How would your mobile unit answer the question of whether or not it's heterogeneous?

MR. MADDEN: Based on what's been collected in large cities, let's say New York City, do you see different measurements at the same times on data?

MR. WILSON: I can tell you about Philadelphia.

MR. MADDEN: Okay.

MR. WILSON: And it's the same day to day of the fine particle mass.

MR. MADDEN: And that's supposed to be the different?

MR. WILSON: I'm sure it is.

MR. MADDEN: You know, I don't know if that's true for every city.

MR. WILSON: But my point is, you need multiple sites that operate at the same time in

order to answer that question. I'm sure that's an issue that will be addressed by the exposure people.

MR. MADDEN: Historically, what's the emphasis to these sites?

SPEAKER: Petros made the case yesterday somewhat subtly that the whole eastern seaboard, from Philadelphia, New York, Boston, were all correlated in terms of their particles, remarkably so.

SPEAKER: That's an experimental finding.

SPEAKER: Is that based on annual average or seasonal average or day to day.

SPEAKER: Daily average, a lot of data on it, fine correlate, point nine.

MR. MAUDERLY: Let's go over here. I think your hand was up first.

MR. COWLING: I'd like to advocate in thinking about siting a couple of different things that have to do with how the decisions are made about sites. Often when I've seen interactions between two disparate science communities requires mutual agreement among those disparate communities about where to go and when to go, and under what circumstances to do the measurements, and ideally it would involve joint financial agreements about the support systems and persons, and so on that need to be developed. So an optimum site is a site where many

investigators have mutually agreed by lots of discussion to go there together to accomplish things they believe in for their own purposes, and no matter how optimal a site might be, if you can't get the integration of the intellectual efforts, it will be of much less value than if you can get a significant mutual commitment to working together and that ideally the base of experience intact in doing that. Willingness to be cooperative means a commitment to do more than you've agreed to, because somebody will fail to do what they had agreed to often for very good reasons. Trust among people who have learned to work together is so crucial and important to the success of the science enterprise, particularly in the multi-disciplinary that optimum siting requires optimum choices among people who mutually have agreed and where there are tangible courses of experience and the experience in publishing together so that you can be comfortable. You will get something of value.

MR. MAUDERLY: Well, I agree, and what you say makes sense and applies to almost any collaborative venture. We'll probably all agree with you now. Apply that to this issue. What's the application of that? How does that help us resolve this issue?

MR. COWLING: Well, I thought we were talking about other aspects of siting than just that

point.

MR. MAUDERLY: That's the one we were talking about right now. I mean, that is an issue. You have a health community telling you they want the mobile sites, and a measurement community saying that's a dumb idea. Now, that isn't an adequate comparison, but the modeling community I think, still wants mobile sites.

MR. WILSON: Why does the health community want mobile sites? They probably want mobile sites because you want to do a study both at a retirement community and you'd like to have your measurements right there, close by.

MR. MAUDERLY: That's one example.

MR. WILSON: In our earlier discussions we've sort of concluded that that's an impossibility, and anybody who planned a study at a retirement community with the assumption that a EPA contractor would have the right stuff up there at the right time, has had no experience dealing with EPA contractors, and that you'd be much better off to make your own measurements that you're probably going to want to have some personal monitors, you know, indoor measurements, and you might as well go ahead and pay for the outdoor measurements because that's a small part of your program.

MR. MAUDERLY: Are you positing that EPA is incapable of having a contractor do what we want them to do?

MR. WILSON: It's been my experience in 25 years that it's rarely been possible to make that come off.

MR. MAUDERLY: You might have the wrong contractor.

MR. WILSON: I think I might have the wrong agency.

MR. MAUDERLY: Well, that could be.

MR. COWLING: That's why contractors are not the way to ensure optimal scientific commitment, no matter whether you're dealing with mobile sites or any other kind of site. What you want are agreements between individuals who will work together and have demonstrated that capacity to do that.

MR. MAUDERLY: Okay. We take your point, but we really do need to, I mean, I don't think anyone would argue with your point, okay.

MR. COWLING: Will it be made into a primary session?

MR. MAUDERLY: Probably not.

MR. COWLING: That's what concerns me. I believe that it is worthwhile to the health

community and the measurements community to think together today, before they go to the plenary session about how they will try to ensure that the health community of this country and the measurement community of this country will learn how to work together over the years that are going to be necessary for us and that we state that up front as perhaps among one of the most important things that needs to be said during the plenary session about the whole question of how these two communities are going to learn to work together, that you're going to have to work together for years if we're going to make a go of it, and I, forgive me for being insistent here on perspective, and I'm biased in this regard.

MR. MAUDERLY: But isn't that what this whole meeting's about?

SPEAKER: Well, it might have been about that had the star grants been announced before, at the same time the monitoring plan was being put together, but most of the research money is either committed already or nearly committed from the health community to allow someone to have thought about doing a supersite co-location.

MR. MAUDERLY: I thought we were talking about the future here.

SPEAKER: But the money is part of the future.

SPEAKER: The money's going to drive interactions.

SPEAKER: The health people, that you said to work together with someone needed to know that there were the supersite to design and get a project funded on. Those, most of solicitations where the near term money has already been submitted. There's no loose change out for health guys.

MR. DREHER: But there is an RFA out, I hate to interrupt again. There is an RFA out for five or so particle research centers.

SPEAKER: They're due in October.

MR. DREHER: The end of October.

SPEAKER: And there's no supersites being planned.

MR. DREHER: And my view is that there should be some coordination between the particle research centers and the siting of the supersites.

MR. NEAS: That's correct. There should have been, but it's very difficult to figure out how most people....

SPEAKER: There should have been, Lucas, but there has not been.

MR. NEAS: And there will be some.

MR. DREHER: There's still some flexibility. I asked John Bachman, they need to locate at least two supersites immediately, and then there

would be some flexibility of some of the out year supersites that are established not immediately.

SPEAKER: But back to what Ellis is saying, it's true. To make these things serve health needs, you really need to know where they are and what they're going to look like , and in fact, someone is going to be there to use them.

MR. JANSEN: Why can't you go the other way?

SPEAKER: Either way is fine. It doesn't matter which comes first.

MR. JANSEN: My point, I'm John Jansen, Southern Company. My point would be, if you've already got a bunch of health studies that have been proposed and planned, that are going to get funding, then one of the criterias for siting is to do an inventory of those opportunities.

SPEAKER: Again, that's correct.

MR. JANSEN: And see what one can do to enhance them, and it is not, it's not a done deal yet. One of the criteria is to look, I believe you have an inventory of measurement programs that are being developed or are ongoing. Those provide opportunities for the disbursement of these funds for supersites to get more than just seven sites. You also have a bunch of health studies that have now been funded or are just about to be funded in various locations that have

monitoring as part of those programs. Those provide opportunities for enhancement to make them better. I would advocate that one of the criteria is to look for opportunities for enhancement as opposed to we got to have seven, and they got to be fixed or they got to be mobile. I think you can also look for opportunities on the spatial variability question, which is what the mobile tends to, I understand that there are, I want to study this community, I want to have data for that community, but there's also the spatial variability question associated with epidemiological studies that can be tested through targets of opportunity and a key example of that is the study that EPRI and Southern Company and other utilities, the DOE and API, and others are funding in Atlanta where we are trying to bring, use Atlanta as an opportunity because there was a bunch of resources being planned. That's an opportunity to enhance that particular place, so I don't think we've made that decision. I think we still have opportunities for collaboration.

SPEAKER: There are opportunities, but as opposed to an optimal solution of having known where the sites were going to be, either the health sites or the, with their need for monitoring being considered.

MR. JANSEN: It's not perfect, but we can recover.

SPEAKER: It's not close even for the

kind of cost involved in these.

MR. MAUDERLY: Let's go back to Jane. She's been waiting patiently for some time now.

MS. KOENIG: When I read the mobile versus fixed sites, I think a fixed site would be the most, have the most comprehensive measurement, but I think we were thinking that mobile site would be useful, would be like a satellite site, and it could be used to look at other cities in a region to see how the PM variability, see what the PM variability is in those satellite cities in different parts of a, of an air, of a big air shed, and use that to just get more information about the region, and even though, you know, I don't think that we were thinking about mobile being moved every two weeks, but maybe for a longer period of time, an entire season, something like that.

MR. MAUDERLY: William, you had a question here.

MR. WILSON: I wanted to say that I agree whole heartedly with Ellis' comments, but my experience in EPA has been that you build this up largely by working through cooperative agreements, and it is very difficult to do this working through contracts, and the basic supersite has to be done as a contract because it is a direct requirement of the government, and we're not allowed to do it as a cooperative agreement. It is going to be very hard to do the kind of

things you're talking about. Now in terms of, there are going to be, you know, if you think of putting this in Philadelphia, that I'm more familiar with, basically the same thing holds over, the supersite need which drives the, getting the money to do this is to determine what the sources are so you can tell the state people what they have to control to meet the standard, and we you get to far away from that, there is no justification for them to do it. They're going to want to put a site somewhere and run it for a year. John, you're too late, because I've had to tell them what the supersites to do, so correct me if I'm wrong here. Now there's going to be interest on the part of the implementation program, of the exposure program, and knowing the distribution across the city. So there will be satellite sites that will be operated, many of them for the whole year. Perhaps not the complete suite of equipment. Perhaps not the same frequency, but there will be a lot of information on that, and it is, it's possible that you might have, whether they're movable or mobile depends on whether, you know, to me a mobile site is something that measure while it's driving in the streets. A movable site is something that you can drive and sit down for a month or a week, and then a transportable site is something that you can have a truck come and pick it up, and you want to leave it for a season or a year. So when we say mobile versus fixed, we have to talk a

little more about what we need. Now it seems to me, and I hadn't really thought that panel studies could be a useful part of the supersites, but it is conceivable that the supersites could have, you know, movable or transportable sites, and as part of the spatial variation study could do several intensives during the year, where for a month you might measure lots and lots of things, and it's not unreasonable that those could be sat down at a specific site where you had your panel.

MR. MAUDERLY: That's exactly the kind of thing that health people are talking about.

MR. WILSON: Whether what you gain is worth the effort of getting it is questionable in my mind, but if you think it is, you can certainly say that you should take opportunities so that intensive studies could be located at places of health interest and coordinated with health studies.

SPEAKER: To help William understand why it is important. To gather huge amounts of time resolved quality data to do a time series study, in some people's opinion or chronic studies is not exceptionally valuable unless that's what they make their living. But where you can really get the best bang, where you can get something useful from highly time resolved, highly detailed data, is in fact where you have panel type approaches, where you know the most about the subject and you can follow them very

closely, and you can correlate with an effect that may have a short time frame about. So that's in fact a very potentially valuable use for a supersite, and most likely if there, a community, if it's sited and there's some fund or some interest in doing work on health, panel studies would accompany these kind of locations as an opportunity. Because I know how expensive it is to set up a time chemically resolved network just to serve a three or four month panel study. It's very costly. So those kind of things are very valuable uses for a supersite. Much more than the chronic studies and potentially more than even time series studies.

MR. MAUDERLY: Yeah, and I think, I think your definition of the three terms you moved, mobile, what were the others, transportable and movable.

SPEAKER: Yeah, mobile, movable and transportable.

MR. MAUDERLY: We've been using the term, we the health community have been talking mobile because it moves. It's not fixed in the fourth floor of some university laboratory, but in fact, in your parlance what we are talking about is probably the third case where you would move a capability to an area and you would use it probably for a season or probably never as long as year, but that it wouldn't be for days or weeks, and it certainly doesn't drive around the city

on any given day.

SPEAKER: If you have a 25 inch tv with a handle on it, that's a portable tv, but you really, I don't want to move it. Do you remember the old days of portable tv's.

MR. MAUDERLY: You've been trying to make a point for some time. Let's get to that.

MR. HALES: Well, it seems to me, I guess I want to pick back up on what John Jansen said.

MR. MAUDERLY: This is Jeremy Hales.

MR. HALES: Jeremy Hales, yeah, right. What John Jansen said a while back about taking an inventory of what is going to go on in the health effects community and using that as one guideline for establishing these stations. I can think of several other guidelines and maybe it would be worthwhile to couch it in that term, rather than saying we want to go for movable or we want to go for non-movable, but say here are the guidelines. Number one - we need to assist the planned health effects studies that are on the drawing boards right now as much as possible. Number two - we want to try and take advantage of existing measurements facilities as much as possible to co-locate where there are measurements going on to take advantage of that. Number three - it makes a lot of difference whether we're talking about chronic versus

acute effects because chronic implies to me that we want fixed stations. Acute effects implies to me that we maybe want to go into mobile stations, but regardless of this, we've got to go to one conceptual model or the other. Now the movable stations or the transportable stations could be envisioned as a user facility because it's deployable, and that's a model that is totally different than fixed stations. But it seems to me that it's real important to gel that conceptual model at this point. So number one, guidelines, and number two, conceptual model of what we're doing here.

MR. WILSON: Well, let me just comment that what we're doing is not figuring out how to utilize the available money for a health program. What we're trying to do is to see how a existing program aimed at SIPS can be modified in order to also serve the needs of the health community.

MR. MAUDERLY: To what extent can we leverage something that is going to occur in order to gain on the health side? Jane.

MS. KOENIG: Well, I guess I'm wondering what role state agencies are going to be playing in these supersites. Would a criteria for a supersite be that a state agency had expressed an interest to work with other researchers of that sort?

SPEAKER: The answer is yes, and one of the obvious reasons is supersite is just as

mobile or movable or whatever platform that has all the bells and whistles. If we want some kind of spatial understanding and so forth it's going to take, people have used the term satellite monitors, the most economical way to get those would be to use some of the other of the chemical speciation sites and those are in fact, are run by states, and if the states don't want to run that number or that place it wouldn't be a very good place to go obviously. So places with confidence to do that. The other thing, I guess I wanted to add at this point about that is, I'm greedy as far as picking the brains here, and I don't want to simply limit, you know, what advise you give us to what we do explicitly with the supersites but with the other sites, and I wonder, at least after yesterday, it seemed to me that panel studies and some interesting new kinds of panel studies people are thinking of, having to do with cardiopulmonary responses and so forth, match very nicely with supersites where you want to measure some more esoteric things that might associate with those interesting new hypotheses, but that leaves out, apparently it seems to leave out much for chronic. It certainly leaves out something for daily time series. Petros Koutrakis, please don't tell him I said this, had a great idea, and I thought maybe we could, maybe we could throw this one out and see what people here think about, the health folks here think about it. Take ten of

those fifty sites where we are doing, probably the ten in the biggest cities, because big cities are good for time series for the traditional clunky indicator like mortality and hospital admissions and try to get everyday sampling in those places. Now that would take state cooperation, that's why I bring it up here, or at least every other day as a, in other words, take, what is your thoughts about that approach as a way to get at the time series as well as some chronic information. So I'm asking the group.

MR. MAUDERLY: And specifically the proposition is...

SPEAKER: The proposition is...

MR. MAUDERLY: Daily measurements of which kind of site are you talking about?

SPEAKER: Daily measurements of, I'm talking about the so-called routine chemical speciation sites that Petros Koutrakis presented yesterday with the kinds of measurements you saw them list as priorities, but done not once every third day, which is the plan at this point, but everyday in a subset, ten, not fifty. We couldn't afford it. We don't even know if we can afford ten, but we might. The real issue is at what point the states are going to have to collect the samples everyday, and some of these aren't automated. What could they break down, but what

about that idea I guess? And as far as that's concerned, chemists could speak to how we might do that everyday.

MS. KOENIG: I think the health community would like daily measurements if they're given the option.

SPEAKER: And where would you like them? I mean, the going in position is that the fifty sites are going to be in relatively large areas. What kind of places would you want them to be?

SPEAKER: Are you talking about putting them downtown or are you talking about putting them in an urban area, or what, because that can make a difference to me.

SPEAKER: Well, tell us what you're interested in? The initial thing with every one of these sites would be in a major metropolitan urban area. I think we couldn't afford to put, to run more than one everyday, but if there were satellite sites around that that ran every three days of x more, to help you get some spatial sense, we'd still have something useful I think.

MR. MAUDERLY: Do you want to follow up on your question, comment on that?

MR. WILSON: Obviously if you're putting a site, you know, by the bus stop, if you're trying to use it for regulation or whatever other purpose

that they're using it for, it's not going to be very much...

SPEAKER: We're asking you to tell us where to...

MR. WILSON: So I wouldn't want it there.

SPEAKER: Remember the purpose of these sites is over arching trends. It's certainly not to be located next to the hottest source. You wouldn't put it in New York City in the Wall street district that has super high containment of diesel bus emissions necessarily. But so, remember our standard isn't a spatially average standard. People have forgotten that, but in fact it is, and we did that because we're trying to capture what the city is exposed to not the people individualized.

MR. MAUDERLY: We went through yesterday the different kinds of studies and we already said that we want, we want daily measurements. You need daily measurements for time series studies. So I guess, I mean, that's an answer that the other part of the answer you're looking is for is where in the city do you want it?

SPEAKER: Well, where in the city? What kind of cities? I mean, we're talking location.

MR. MAUDERLY: People that would contemplate such a study, what do you think?

SPEAKER: I would say it's the same problem we are at right now. It's no different whether you call it a speciation sample or you call it a supersite sampler. Again until you have a very specific set of studies in mind, you can't answer it any differently than you have, do this. Especially if you're given one per city, well, that's a whole lot like a supersite because it's just one. So I guess, just my two bits worth, try to put it, if you have a panel study in mind, you try to put it somewhere near, if you've got a population figured out you want, near a hospital, near a clinic, but nobody can tell you where that is today, because there isn't that study in place. You wouldn't want it in the middle of the city in a very heavily urbanized area unless, you want it in a quote representative site, and of course we can't tell you what the representative site is. That's what the monitoring people can tell you. So to answer that question's really hard, John. There's no study underway.

MR. JANSEN: No, but saying representative sites, I guess I was trying to expand the discussion here which seemed to be focused on panel studies, varying that, which I think is right for a supersite. It seems to be right. To broaden the question ask the question, if you're doing time series using the neo-traditional indicators that you can get, where would you want to locate it. I think you've

already said, representative which is clearly in the guidelines for our monitoring siting is representative of the population.

MR. MAUDERLY: Most time series studies draw off from populations in a fairly broad area. We talk about panel study being a restricted population, a targeted population, old people, people with green hair, whatever. I mean, it's a targeted population. But time series studies, at least those that have been today, usually draw from broader area, and you want a representative sampler. Having one parked at the corner of 5th and Elm may not be the cat's pajamas. On the other hand, if all your old folks are located at 5th and Elm, why that's where you want to do the panel study.

MR. WILSON: Well, it seems like one recommendation could be then when you pick, if you were going to do ten, and I've heard discussions if you were going to do a chronic study you better go to a clean place, things like that. But if it's a, for time series studies, if you're going to pick your ten sites, you had better talk to the epidemiologist on what would, you know, instead of just taking what we give you, which is what they normally have to you, we're going to give you a shot as to where it goes, and it sounds we should do that.

SPEAKER: Jane, you've been trying

to get...

MS. KOENIG: When you say a representative site, you want to be sure that it's a site that's representative of a residential area, that isn't close to any industrial parks usually, and isn't close to a roadway, all those siting things that your state agency could probably help you with, and I think you'd want to put it in a community where there's a fair amount of variability in PM, so you're able to get a signal.

SPEAKER: Don't do ten north-eastern sites. They're all the same.

SPEAKER: So if we just took the ten biggest that might be a better criteria.

SPEAKER: Are we talking about a cross sectional situation here where you're getting data from ten different cities on health and exposure data from those cities, or are we talking about going to one city and looking at all the stations there and going through? Because there's a big difference.

SPEAKER: We're talking about ten time series studies.

SPEAKER: Ten different time series studies.

SPEAKER: Why just time series?

MR. MAUDERLY: You just came in. We had a point being made that was relevant to those

kind of studies. We've talked about panel studies. We've talked about chronic. Yesterday the question that came up was relative to time series. That doesn't mean that that's the only kind of study. Yes, back here.

SPEAKER: I have a sort of a specific question response following up on my comment earlier about opportunities. In terms of where, you ought to look at where are studies are either planned or going to go on, and I would submit that you also open the door to the spatial and the speciation monitors. Why enhance just to suit the one, the one site that is these fifty? Why not even consider enhancing the other, some subset of the other two fifty that are going out that might be, for example, Atlanta. There's a major epidemiological study going on. We really could use some resources to enhance the frequency of collection out of all of the speciation monitors that might occur in Atlanta in conjunction with Georgia Tech is doing and others so that we have a one year period, I mean, it is 18 months, but a one year period where you have daily data at as many sites as you can around Atlanta to truly test the spatial variability. So look for opportunities. Look for ways to leverage your resources and I have a provincial interest in that particular one because we are, we are doing it, and we could use help.

MR. MAUDERLY: Well, that goes back to your point in that we, another point I think that

is understood, but we probably need to verbalize and that is if we're talking about for instance a speciation site, collecting samples everyday. We're not talking about all speciation sites doing that for the next 20 years. We're talking about a planned study where there'd be an agreement that a site or set of sites would do that for a specific period of time which again, goes along with the commitment and cooperation and design a study. But the point, back to sampling is, that we're not, in many of these cases, we are not contemplating recommending that all these sites do this all the time.

MR. DREHER: I'd like to return to Rick Burnett's comment about the many sites, in many sites, air pollution from a variety of sources rises and falls together to the meteorology, and even though it's from different sources, mobile sources, long range transporters, there's still a high day to day correlation between the levels from these different sources, and for to distinct, for us to distinguish between the health effects associated with mobile sources versus long range transport, we'll need sites where there's some sort of reduction in this correlation between the levels associated with these two sources. I think that's the point Rick was trying to make. Why don't you expand on that since you are...

MR. BURNETT: Well, I think that's, that the only other to expand is that ideally we need

similar types of studies, whether it's a panel study or a time series studies, or a whole suite of them in many or all of these sites, and then through meta-analysis we can actually look at those contrasts and contain those results that we're looking for specifically, but it's possible effects of one type of pollutant from another type, and I think that's the other key is to try to get, you know, if something's going on in Atlanta and that looks like a really promising, you know, epidemiological design, can we do that in Seattle, or can we do that in Phoenix, or whatever, you know.

SPEAKER: I'd like to add, if they're going to set up a bunch of monitoring sites in Atlanta to help these fellows out, sampling everyday, I'd like to know about it, because I might be able to find me a susceptible sub-population and do my study at the same time. That kind of information needs to be shared.

SPEAKER: But that would be a real great advantage that if you're having a monitoring, a national monitoring program that you'd have some kind of coordinated national health program with it.

MS. KOENIG: You know, I'd really like to add that I think you need geographical disparity so you can take advantage of many different sources of PM and begin to get some kind of separation.

SPEAKER: If I can paraphrase this, you would like to have different cities where you have

different mixes of pollution and where there are different correlations between the different types of pollution, dramatically different.

SPEAKER: Which is, which is exactly the goal of the SIP program, too.

MR. MAUDERLY: As differently as you can get from them, and the key point there being, in contrast to some of the discussion as to well, if there's going to be a particle research center, a university center in city x, then we need a site there because that's where these studies are going to be. The concept is, look, we need to look at this as a national, if not international, array of sites and studies. There need to be coordination and take advantage of the differences. It's very limited kinds of studies can be done totally in one location. That's the key point I think. It's a good point.

SPEAKER: I think, really, any place you set up one of these supersites, if it's a large population, it's going to be like a bug light to bugs. The people are going to go there and find their populations through their sampling. It's going to draw rather than put it where people want it. It's going to draw people to it, so you need to augmented in that.

MR. MAUDERLY: Three things attract scientists. Money, coffee, and data. Free data.

SPEAKER: Free coffee.

MR. MAUDERLY: Good points. Other points about siting? Have we exhausted you? A moment ago we had lots of hands waving. Must be because I said something wrong then.

MR. FRISCH: I want to ask the question as sort of the innocent in the crowd here. Since PM has never been my area until about six months ago.

MR. MAUDERLY: And your name.

MR. FRISCH: I'm John Frisch from APO. Is there a presumption, a sort of a implicit assumption in siting, that you're picking places that have a temporal variability in the data that you're collecting?

MR. MAUDERLY: That's a good question. We talked about spatial variability, City A being different from City B. To what extent do we value temporal variability at a given site.

MR. FRISCH: And from an epidemiologic standpoint, which I think is part of what we're talking about here, if you don't have some variability in time, you don't really have anything to look at. If you've got a flat line in your exposure data, there's nothing to compare.

MR. MAUDERLY: Well, as a first cut, I'm not an epidemiologist, and I want Rick and Lucas to answer the question.

MR. DREHER: Let's make it clear, that he is a toxicologist, and a very good one.

MR. MAUDERLY: At the first cut again, as we just said, in order to study effects you need differences in exposure. If you're going to be limited to one site, then I would think you would want to maximize variability at that site. But what we just said is, we don't want to be limited to one site, and so you want disparate exposures at two different sites. I mean, that's sort of a general principle. Rick, do you want to respond to that? What about variability at a given site? How valuable is that?

MR. BURNETT: Well, it's the whole thing. I mean, you want to have the more variability you can have, in fact, even if you could nest a times series study where you had different types of pollution episodes, transport episodes, bringing in one mix versus local source inversions as another mix. I don't know if people have ever looked at that kind of thing with a health study, and that could be, you know, done within a time series study, too. But you know, variation is everything.

MR. MAUDERLY: Let's talk chronic for a moment. Let's say we were going to redo the six cities studies. Well, not redo that study, we're going to set up a study that involved different cities, and we're going to look long term at the associations between air

quality and health. Would variability within a city, be a benefit or a detriment?

SPEAKER: Could you define variability as temporal or spatial, please?

MR. MAUDERLY: Well, we're talking temporal. We're talking temporal specifically now. In that situation, which is only one of several potential kinds of studies, but in that situation, would temporal variability in a given city be an advantage or disadvantage?

MR. DREHER: Well, in our re-analysis project of those two ACS and six city study, it's been clearly suggested that we look at other measures than long term averages, such as variability, seasonal variability, peaks, number of peaks, duration, other measures. Coming up with a hypothesis. You know where they're searching for that thing, but that's really my suggestion.

MR. MAUDERLY: Okay, so temporal variability is a value. Lucas, do you have any comment on that?

MR. NEAS: In looking at the time series study of mortality and hospitalization, we see consistency broadly across all of these studies, but there is some variability in the magnitude of the effect across different cities in the association of day to day variation of PM, with day to day variation of mortality.

It may be possible to exploit this if you could determine what characteristics identify cities that seem to be more, have individuals which are most responsive to air pollution. The problem with spatial variation is that you have to have a very good characterization of the population on study to compare differences in spatial variation. For example, and the point has been made by Fred Lifberg, and if you think that Steubenville, Ohio has lots of people dying from air pollution, you'd better have very well characterized the people in that Steubenville population so you make sure that they're not just sick for other reasons, and there may be many things that separate Portage from Steubenville. You have to very well characterize the subjects under study so that you're not looking at some other characteristic that happens to co-vary with air pollution. That's why special studies are not done as much in air pollution epidemiology. You have to really make sure there's no confounders. It's hard to see that there's much confounding with time series studies. That's why they're done. But you can design this, but you have to be very, very thorough in characterizing the population in terms of exercise, and diet, and other things which may result in premature mortality.

MR. MAUDERLY: Isn't that another reason though that would bring value to temporal variability? It may just be that everybody in Portage,

Wisconsin eats lots of broccoli, and people in Steubenville don't, but in fact, if you have a lot of temporal variability in both places, you can compare responses that way as another parameter. So I think the answer that you're getting is that temporal variability is an advantage within as a site, as well as differences across site.

SPEAKER: Joe, I would submit that that goes a long way, but it doesn't go all the way. For example, it's conceivable that if one wanted to do a study, in my opinion, of say health benefits of a standard, that an intriguing possible idea would be to pick one place at least that has substantial long term variability, temporal variability through the standards, perhaps another place that didn't. See what I'm saying? I don't think it's necessarily appropriate to say, to make a blanket statement that a long term temporal variability in exposure levels in all places is always the best thing to seize.

MR. MAUDERLY: But the temporal variability I think you're talking about is a longer time trend really to look at benefit of controls, and the point's valid. I think what we've been talking about mostly, and again that point's valid if that's the comparison you want to make. But if the question comes up, should we avoid a site or look at a site on the basis of temporal variability, is that important, and

is that a good thing or a bad thing. For most other kinds of studies, what we've heard is that that's a good thing.

SPEAKER: Temporal, what we've been talking about is temporal on a day to day basis.

MR. MAUDERLY: That's right. On a short term basis, not a long term time trend.

SPEAKER: On a longer term basis.

SPEAKER: Maybe we can unify all of this by saying that knowing as much as you possibly can about the temporal variability of pollution exposure in candidate study sites is always a good idea.

MR. MAUDERLY: Well, that would be reducing our advise to the lowest common denominator. You need to know something about it. You're point's well taken. If you want to get at the issue of do controls do any good, then it'd be nice to have a study where you had controls or didn't have controls. I mean, controls on sources that resulted in time, downward time trends in pollutants. But the kind of variability we were talking about was the short term, the short term variability.

SPEAKER: Given the regionality to the tiers for PM, I've only been in the north-east three months, and I haven't been to any city where I haven't seen temporal variability. Can people give me examples of cities where you don't see temporal

variability?

SPEAKER: On what scale? I mean, in Utah Valley the air pollution seems to go high for a period of a week or so, and so you don't have a lot of day to day snapping back and forth. It tends to be more, but have no variability, I think you'd have to go to, say Mexico City, or somewhere.

MR. MAUDERLY: Just about the time you think you've got a place which is pretty consistent, then you have a forest fire or something out in the middle of nowhere, and suddenly it's bad. John.

MR. JANSEN: It really depends on whether you're talking about for a short term time series versus long term. One of the variabilities on long term that would be interesting is east versus west is absolutely fascinating. We expect that more eastern cities will violate the annual standard and more western cities will violate the 24 hour standard. That implies a different kind of background. They don't have the background day to day, everyday sulfate, you know, coming in, so although there are exceptions such as Los Angeles. But they have profound seasonal differences. We have peaks in the east, peak summer events, so do in the west, but they're very different from the peak winter events that are also in the west, and they have more dust. So the question is, is it interesting in a quasi cross sectional prospective of long term study to

get that kind of spatial and temporal variability built in? And one other thing, I guess I want to throw back and remind us of, although we've focused terribly much on fine particles in this little conference as was, you know supersites are xx to fine particles, and so forth, mostly. But we had better be asking what places let us talk about fine versus coarse. That's still a big question.

MR. DREHER: That brings up another issue about not getting too much variability in all factors. If you have ten supersites and they're all completely different. They all have a different mix completely, then you've said nothing. You know, you've not learned anything about any one fact, you know, there in that mix.

MR. MAUDERLY: I'm not sure I understand what you're saying.

MR. DREHER: Well, if I have, you know, one place has high coarse and low fine, and other place elemental carbon, medium and other things like this and everything's all over, you've not got any, you know, any design of clinical trial, you know. Everything is held constant, and then you have vary at one thing. You've got to remember that if it's in a cross sectional, longitudinal study, you've got to make sure in there that enough things, you've got some of these cities in there where you have a bunch of things that are constant, and then one thing varies at least.

SPEAKER: That's important if there was, heaven forbid, a coordinated health study that tried to use all ten sites. But as far as I can tell, there may not even be one study that we use all one site, let alone all ten sites, so if you want to do a time series on using all ten sites, that would be an important point, and I don't think that's going to happen very likely.

SPEAKER: But if you wanted to do a longitudinal study using some...

SPEAKER: If one wanted to do that, that would be very useful unless they were trying to even get at something as simple as annual, seasonal, or daily mass, and not worried about carbon or not going to hope to get a carbon. They'd be happy to take highly time resolved PM2.5 one and ten mass only as the measure. Then it would still be valuable.

SPEAKER: My point though, you know, that we don't want to conclude that, we know that Steubenville has worse air pollution, and people die younger in Steubenville than in Portage, and the question is, is air pollution playing a role in there, and what type of air pollution. So we don't want to just say this city has a different mortality experience than another city, or a different asthma experience, or whatever. We want to understand why those differences are and the sites are picked so that they're, you know, they're a completely different mix, and there's nothing

common or weather is completely different, and so on. We'll never tease out any one thing.

SPEAKER: Possibly with that approach, you might not, but maybe with other approaches, you would. The panel studies in highly different areas. Fresno, for example, in the fall have very high PM10 levels, coarse fraction. In the winter, a month later, it's like somebody's turned a switch, and they have exceptionally high PM2.5. I, like a dummy, didn't bring my time series. We've got like eight years worth of weekly data from both fractions. It's like somebody just turned a switch. The fact that it got cold. So you might ask different questions in a panel study or another kind of study looking at seasonality than you might by comparing all ten supersites, five, whatever number they're going to be.

SPEAKER: I was thinking more in a chronic site.

MR. MAUDERLY: Other points? Well, then, why don't we break, since we have plenary in ten minutes, and I'll try to synthesize these individual...

MR. JANSEN: Joe, one thing that was a point six, that we would like at least some of the health community and planning committee would like to know, is a really firm plan about what these supersites, their deployment will be because we talked about

coordination. Yesterday was the first day I'd even seen a slide shown for twenty seconds that had supersite deployment time framed. So if nothing else out of this meeting, it would be nice to know what the deployment schedule is potentially for supersites.

MR. COWLING: One other thing that is of a general sort. It has to do with the amount of money that is available for the analysis and interpretation of the data. I don't know if you've reached this problem in the health community, but in the measurements community...

MR. MAUDERLY: We have no shortage of money.

MR. COWLING: It's a serial disease. We all spend more money on measurements and less than adequate money on...

(**WHEREUPON,** the Breakout Group Session was concluded at 9:20 a.m.)

C A P T I O N

The Breakout Group Session in the matter, on the date, and at the time and place set out on the title page hereof.

It was requested that the Breakout be taken by the reporter and that same be reduced to typewritten form.